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FREE-SILVER POISON THE CAUSE OF INDUSTRIAL PARALYSIS.

By J. Selwin Tait.

THE decision of the people of this country as to whether we shall have free coinage of silver, with all the train of evil consequences attendant upon it, or whether we shall maintain our present gold standard, is of more importance to-day than would be the fact of all Europe sitting in solemn conclave to decide whether or not it should declare war against us. And, strange as it may seem, in point of injury to the country, to its commerce, and to the individual citizen, the debasing of our currency by the free, unlimited, and independent coinage of silver would be a greater evil than even a new civil war.

And herein lies the mockery of the situation. The farmer and wage-earner, stirred by the teachings of interested men, are preparing to test the advantages or claims of free silver just as they would test the fitness of a new pair of boots. They say, in fact: There is no harm in making the experiment, and, if it does not suit us, why, we shall be no worse off than before. They fail to see that they cannot try it as an experiment any more than they can declare war as an experiment, without paying the bitter cost.

The circulation of a country resembles in every detail the circulation of the human body. A man may have a splendid framework, overlaid with such a net-work of muscles as only a Samson could boast of. His vital force may be in proportion, and altogether the man may be perfect in all his parts. You may break the man's limbs; you may mangle that superb body until every movement is excruciating agony; and yet, although the man is badly injured and must be confined to a hospital, he is the same living force that he ever was, and will, in a very short time, be as strong, or nearly as strong, as before

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the accident. But take that man in the pride of his strength, and inject into his veins some liquid which will impair or degrade his circulation, and you at once prostrate him and make him as helpless as an infant, worse off in reality than if he were a feeble dwarf.

And the case is nearly similar where a country's circulation has been tampered with. Macaulay, with his inimitable pen, sketches a wonderful picture of the results of the debasement of the coinage in England in the sixteenth and seventeenth centuries. He shows as no other man could that, in point of the harassment and real misery which that debasement caused, it was a hundred times more hurtful than the worst of wars, and that its effect upon commerce was that of a blight under which nothing could prosper.

It is well, therefore, that all should understand that free coinage is not a thing to be taken up, and lightly dropped if found not to our liking. Many people are deluded with the thought that, as we had it once before, there can be no harm in trying it again. And therein lies our greatest danger. Every condition is changed since that time. Silver has multiplied beyond measure, and has so cheapened itself that its market is broken down. The silver men claim that the act of 1873 brought about the fall in the price of silver,—a statement utterly at variance with facts. Instead of neglecting silver since that time, as the silver men have claimed, we have added more than half a billion of dollars of silver to our circulation, with the result that we have discovered that the more we have purchased the more we have stimulated the supply (which was already over-abundant), notwithstanding the silver men's prediction to the contrary, and their assurance that the purchases under the Bland-Allison and Sherman acts would make the silver in a dollar worth one hundred cents. Silver, after a momentary spurt, declined under these purchases, until it fell to its present figures. The fact is that the purchase of silver, under the Sherman act particularly, was like trying to pump the Atlantic ocean through a hole in the bottom of a ship. The State needed a plaster and not a pump, and it was a plaster eventually that saved the country.

It is, perhaps, needless at this stage to explain what free coinage means. The main point of this paper is to consider what its outcome will be and the classes it will affect.

Mr. Bryan does not hesitate to state that he is against the creditor class,—that he is, in fact, the advocate of the debtor. Now, who constitute the creditor class of this country? The Goulds, the Vanderbilts, the Astors, the Rockefellers, the Armours, etc.? Not at all. On the contrary, they are all heavy borrowers, and, even where they are the holders of bonds, it is usually of bonds of corporations of which they are the owners, so that they simply owe money to them-

selves. The creditor classes of this country are the 5,000,000 savings bank depositors who have money on deposit to the amount of $2,000,000,000; the 1,700,000 share-holders in building and loan associations, whose assets last year amounted to $450,000,000; the members of insurance companies, which have in force nearly 2,000,000 policies, amounting to $5,000,000,000. If the wealth of all our millionaires were welded into one piece and placed alongside the wealth of the common people in such institutions as have been named, it would not be relatively as large as an acorn alongside a watermelon. Therefore the millionaires are of all others the debtor class to whom a panic can do the least harm. Even if it has depreciated, for the time being, the value of their stocks and bonds, they can simply turn the key in their safe deposit vaults and wait for better times to restore values.

Mr. Bryan admits freely that the savings bank depositor, the man who has invested his money in the solid securities of the country, will have his money reduced in value under the free coinage act by its lessened purchasing capacity, and so he says: "Buy property, buy commodities." In other words, "things are going to go up in value; speculate for the rise, and be happy." When we call to mind the people to whom this advice is addressed, and its probable result, it is difficult to believe that we are listening to a presidential candidate in the United States in the last decade of the nineteenth century. Can such a speaker be a responsible person? Just reflect for a moment as to the class of our depositors. As stated, there are $2,000,000,000 in the savings banks of this country, held by 5,000,000 people. Altogether there are probably 12,000,000 of our citizens who are directly interested in these savings. The amounts on deposit average $400 to each depositor. Now, what property or what commodities can the widow, the orphan, the domestic servant, the wage-earner, the salaried clerk whose time is fully occupied in his business, buy with $400? Can they buy real estate with it? Is any one of them fitted to go into the market and buy commodities, and to pit his ignorance against the experience of men in the business? Why, if Mr. Bryan's advice were to be taken seriously, we should see the savings of years gobbled up by land sharks of every description.

Our savings banks have always, and justly, been regarded as the perfection of safety and prudent management. They are hedged around with precautions which safeguard the deposits in every conceivable way. Even during the throes of the civil war, when values generally were so disturbed, confidence in the savings banks was not only unshaken, but grew steadily, so that at the close of the war it was found that savings bank deposits had increased seventy-five per cent.

In his violent attack upon trusts Mr. Bryan allows the silver trust,

the greatest and most iniquitous of them all, to pass unnoticed. This is very regrettable. What are the silver interests in the west? Even now, with silver in disgrace, as it were, the output of these mines averages $75,000,000 per annum at coining rates, while in their palmy days they have paid as much as $175,000,000 in dividends in the space of three or four years. Behind the mint interest stand the colossal estates of such multi-millionaires as Hearst, Flood, Mackay, and a score of others, whose wealth aggregates about $550,000,000. The silver mining men had influence enough to induce, nay, to compel, our government to purchase silver of the value of $500,000,000 to add to our currency under the Bland-Allison and Sherman acts. By these purchases the country has already lost, at current rates of silver, $150,000,000. But their appetite has grown by what it fed upon, and, their demand upon the government having risen from a purchase of $2,000,000 per month under the Bland-Allison act to $4,500,000 under the Sherman act, they now, like the camel in its master's tent, throw decency overboard altogether and demand the whole thing. In other words, they insist upon the free coinage of silver at sixteen to one, unlimited and independent.

But how have they so worked upon the feelings of the people that they have enlisted so many of the farmers and the wage-earners on their side to fight under their piratical banners? Well, for the past two or three years the silver men and their representatives have been engaged in a great missionary work among the farmers. These latter number five million. Allowing the usual American average of five persons to each family, and add two more individuals for hired labor, and we have a total of thirty-five million people directly interested in farming,—that is, one-half of the entire population. If we add the population of those villages and towns adjacent to the farms and depending upon them to a great extent, it will be seen that there are probably forty-five million people in this country who are bound up in agriculture. As all wealth springs from the soil, so the farmer is a great manufacturer of wealth, or property, or capital, which you will; he is also, *per contra*, a great consumer. If he does well, the village store does well, the wholesale house in the city does well, the manufacturer does well, and the wage-earner does well; so that in reality the farmer is the key to the whole situation. Hence the great amount of trouble, care, and expense which the silver men have taken with the farmer. Expense? Yes; probably $10,000,000 would not cover the amount. But we don't know. There is no doubt, however, that London and Paris, where all the profit of our silver mines goes, would contribute handsomely to prolong the life of the silver goose which lays such beautiful golden eggs. Has it entered the head of any one that the vast amounts of money extracted from the bowels of the

earth in Nevada, Colorado, Wisconsin, Utah, and New Mexico are expended on these arid countries? Do they look like it? No. All that money is carried to London and Paris and spent there. England has no absentee landlordism to compare with this.

The first thing the silver men did was to detach the farmer from his allegiance to sound money by endeavoring to persuade him that he had been very badly treated by the act of 1873, which, for the purpose of their argument, they choose to call the "crime of 1873." In passing, it may be stated that the so called "crime" was simply the codification of existing laws touching silver, and the decision to resume specie payments on a gold basis in 1878. The "crime" consisted in bringing this country to a gold standard. This act has met with the approval of every civilized country in the world; it was under discussion for three years, reams of information were printed about it, and there was not a member from the Pacific coast who did not consent to the legislation. Senator Stewart himself was especially prominent in its indorsement. The fact is that at the time that law was passed there was no profit to be made in free coinage, since the price of silver was higher than the price of gold. It was not until many years afterwards, when the price of silver had fallen considerably, that it entered into the heads of the silver men that it would be a good thing to revise that statute in their own interest. Knowing the extraordinary alertness of the silver men, no sane person will believe that any legislation affecting their interests could take three years in passing through congress without their knowing all about it.

By the use of distorted figures in parallel columns the silver men have sought to show that the price of silver began to fall in 1873, and that promptly it proceeded to drag the price of wheat down with it. The audacity which they showed in printing figures entirely at variance with fact was a source of great gain to them, until the writer exploded their theory by showing that reference to the files of the Chicago stock market proved that the fall in the price of wheat, instead of beginning in 1873, when silver began to drop, did not begin until 1883, and further proved that at no time was there any sympathetic action between the price of wheat and silver. The silver men talked so loudly about the farmer's losses since 1873 and the ruin brought upon him, as they claim, that their mere insistence gained many converts. To every one it is apparent that the price of wheat at the great central markets had fallen off much. This was inevitable from the fact that between 1875 and 1891 the wheat area under cultivation in this country had increased over forty per cent., while India, Russia, and the Argentine Republic, with their cheaper labor, fertile lands, and splendid climate, were flooding our European markets with cheap

grain. The silver men have closed their eyes to that argument, and reiterated that it was the "crime of 1873" that caused the price of wheat to go down.

United States senate document No. 316, of the present congress, gives the statistics since 1862 of the four great States of Iowa, Kansas, Minnesota, and Nebraska. This table shows that from 1862 to 1890 the average price of wheat *on the farm* was 71.05 cents per bushel, as compared to 71.4 cents per bushel in 1862-66. That is to say, for nearly twenty years a uniform price was maintained. During this time the farmer's position was greatly improved by the discovery of cheaper methods of cultivation and a considerable fall in the price of all articles purchased for his own consumption.

It is perhaps a thankless task to prove to any man that he is not so badly off as he fancies himself to be, but that he is in reality better off. Such, however, was the case up to 1890. For a great prosperity overtook the country, as a result of the act of 1873, and continued from the resumption of specie payments in 1878 until 1890. In that year, however, the Sherman act began to inject its enormous flood of silver into our circulation, thereby weakening the whole character of our money, and creating distress at home and abroad, which closed our factories, threw our wage-earners out of employment, and hurt the farmer So the farmer's loss was caused, not by the so-called "crime of 1873," but by the iniquity of 1890.

Now the question arises: What will the people of this country, and among them the farmer, gain by free coinage, and what will be the course of events following upon its introduction? Under free coinage it is proposed to coin free of charge all the silver which can be offered at the mint,—that is, presumably, to the working extent of the various mints, which is $50,000,000 per annum. There has been no talk up to the present time of issuing certificates against these deposits for coinage; so it behooves us to stick to our text. Here, then, we have a gain $50,000,000 per annum. But, inasmuch as there can be no doubt that all the gold in this country will take to its wings and fly away the instant free coinage becomes a certainty, we have a loss of $600,000,000 gold from our currency, as a set-off to this yearly gain of $50,000,000. In other words, it would take twelve years for us to bring our circulation up to its present figure of $1,700,000,000.

Such a contraction of our currency would instantly bring on a panic which would convulse the country, stop all our manufactures, and fill our streets with starving workingmen out of employment. This would, of course, instantly react upon the farmer. None of the silver men dispute the certainty of a panic on the introduction of free coinage; but all content themselves with the belief that it will be short-

lived, and then, say they, we shall move on to better times. What a delusion! Because this country steps down to the level of Mexico, China, India, and the republics of South America, does that mean prosperity? Has it meant it in those countries? A cheap 53-cent dollar would mean, as it always has meant, a cheap country and a cheap wage-earner. Meantime, during the business stagnation, which would undoubtedly last for years, the world's trade would go past us, and who would be bold enough to say that we should ever regain it? It has not happened once in the whole history of the world that commerce has returned to a country which it once left.

Certainly no enemy would have dared to attempt the injury to this country which the silver men have assiduously tried to commit during the past few years. Would the wage-earner be better off under free silver? Impossible. Supplies would cost him nearly twice as much as now, while his wages would remain as they are, if, indeed, he should not be thrown out of work by the panic which must inevitably follow free coinage. The farmer and wage-earner will very properly ask at this juncture what is he to do, if he is not to vote for free coinage of silver. Times are admittedly bad with him now, and have been since 1890. What can he do to improve them? The answer to this is that both have been very much deluded in the belief that free coinage would mean to them more money; they have listened to proposed remedies which the experience of the entire world has proved to be a delusion and a snare. This country does not want more money. It could do an enormous business to-day on half the money capital which it has at the present time. The trouble is that the continued agitation of the silver men and the uncertainty as to the outcome of their efforts have bred distress on every side, and the money that we have has lost its fluidity or mobility; it does not circulate.

If it were possible that the whole world should understand to-morrow that this country through all its parts was well content with its present circulation, and that all agitation would at once cease, and would not be resumed during the next ten years, so great would be the influence of the confidence felt that within two or three weeks business would be all that every one could desire, and the profits of the farmer and the wage-earner as assured as either of them could wish them to be. Just as the French Revolution could be explained in one word, hunger, so the badness of our present trade can be explained in one word, distrust. It is not the banker who has locked up money, as the silver men mischievously state. Locked-up money brings no profit to any one. It is the lack of confidence, the lack of certainty as to the future, which destroys the courage of our business men and reduces the commerce of the country to its present low ebb.

GAS VERSUS ELECTRICITY DIRECT FROM COAL.

By D. M. Dunning.

FOR a number of years we have heard of the great things that were to happen when science achieved the production of "electricity direct from coal"; yet it does not seem to have occurred to many that ordinary illuminating gas is, and always has been, produced "direct from coal." The purpose of this paper will be to show in a practical way that, with the modern gas works, handled in an up-to-date manner, an efficiency can be attained which is about all that could be produced, even should science succeed in the production of "electricity direct from coal." In doing this it will be desirable first to briefly describe the modern gas works and some of the essential advantages to be derived from it, in comparison with the works in use until the past few years.

The day has certainly gone by when the gas manager can sit quietly around and allow his works and business to run him. He must now reverse things,—run the works and push the business; and so thoroughly has this become recognized that the industry, where properly managed, has already become one of the most prosperous in the land. It has held its own through the shrinkage of values and financial reverses of the past few years better than almost any other, and, where it has kept clear from electrical entanglements, has paid its dividends with surprising regularity.

In the way of the utilization of residuals, and illumination through incandescent lamps, it has, through the aid of science, made most rapid advances, and still presents, in these and other lines, the broadest fields for scientific research and investigation. At various times it has, in the minds of many, been threatened with serious, if not fatal, competition from electricity; yet the gas industry is probably to-day in a healthier and more prosperous condition than it would have been if electricity had never been a competitor, because the electric light has created a demand for more light and a stronger light, which, together with its competition, has stimulated the gas industry to improvement, and to advance and extend its business; and on these lines, and with the aid of lower prices, the future manager seems to have an almost unlimited field.

In the evolution of the modern gas works one of the first and most important steps was the construction of the "regenerative furnace."

Only a few years ago, with the old-style furnace then in use, it was the common thing to consume fully one-half the coke produced, in the furnace itself; and, with no special effort made to find a market for the other half, it often became a cumbrous thing about the works, and was disposed of in liberal measure and at nominal prices, which practically destroyed its market value. We now have in common use the "regenerative furnace," which, with its essential features of primary and secondary combustion, is a remarkably economical generator of heat. By secondary combustion I mean the combustion of the unconsumed products of the first combustion, which is brought about by a secondary supply of air at a point just above the furnace proper. In this manner, together with an ingenious arrangement of flues for heating the air-supply with the otherwise waste heat of the furnace, the efficiency of the furnace has become fully doubled, so that we are now able to carbonize our coal with about one-fourth of the coke produced. Another important advantage of the modern furnace is the transfer of the coke without quenching, whereas, with the old furnace, it was necessary to quench the coke, and then fire it up again. This furnace also affords a very marked saving in depreciation and labor, especially if run with moderate heat, as it should be; and the large amount of coke saved, if properly stored and marketed among people educated to its use, becomes a very important by-product, and, in such works as are in proximity to the bituminous coal fields, nearly, if not entirely, liquidates the coal bill.

And, with the great saving in this by-product, there has been achieved a still greater in the two other by-products,—namely, tar and ammonia. Within the memory of the writer, coal-tar was a serious annoyance to the gas manager, because it had to be disposed of in some way other than as ordinary sewage; and it was not an uncommon occurrence to be obliged to haul the major portion of it out into the country and there burn it, hoping to sell the remainder for local use for enough to defray such expense. To-day it can probably be safely said that in no branch of chemistry has science delved so deeply as in that which deals with the black and sticky mass of coal-tar, and certainly from none has it produced more brilliant results, the productions being already numbered among the thousands, comprising nearly all of our most beautiful colors, such as the aniline series, and the most important of our medical remedies, one of which—phenacetine, of the anti-febrin class—has acquired a world-wide reputation; altogether, the list seems as limitless as the starry heavens, and as yet about as unexplored. Saccharin, a thousand times sweeter than sugar, suggests that, if we have sufficient faith, and work, we may yet live on tar. Coal-tar products have acquired so important a

place in the arts, sciences, and manufactures that this by-product has become a well-established article of commerce, and undoubtedly pays, for the average gas works, about twenty-five per cent. of the coal bill.

Not until a recent period did gas companies—in this country at least—make much of an effort to save their third important by-product, ammonia ; and it is an interesting feature of this saving that the necessary treatment of the gas in process of manufacture, in connection with such saving, has been so material an improvement over the old treatment as to more than compensate for any added expense caused thereby, leaving the ammonia saved out of the question. Formerly the gas was often washed in a shower-bath of cold water, and many of its illuminants were washed away with the ammonia into the sewer. Now only an exceedingly small quantity of water (which has great affinity for ammonia) is allowed to come in contact with the gas, and this contact, by ingenious mechanical contrivances, is continued over a long and sinuous course, entirely removing the ammonia without disturbing the illuminants, and producing a valuable article of commerce. The storage and concentration of ammoniacal liquor requires careful and skilful handling, as it is an extremely fugitive substance, always anxious to escape to the clouds, and return thence to the farmer in his fields. Five to seven pounds per ton of coal is a fair production of this by-product, and betweeen thirty and fifty cents per ton of coal the average revenue.

This summary of the state of the gas industry at the present time, in respect to the saving of residuals, brief as it is, warrants the statement that the dividends of to-day are declared from the wastes of yesterday ; and the knowledge of it seems to touch, in the mind of the gas engineer, whenever by chance he happens to gaze at the chimney of an electric-lighting company, a sort of sympathetic chord in harmony with the feelings of the stockholders thereof, in the shape of a vision of dividends vanishing in smoke, worse than wasted, because an intolerable nuisance.

Important as the mechanical evolution of the industry has been, it fairly sinks into insignificance in comparison with what has been accomplished and with the possibilities in view, in the evolution of the business end of the industry, following the line of enlarged output at lower prices. And, in mentioning lower prices, it is well to suggest how very much depends on a proper representation of the industry to the people, as it is not so much what the people pay as what they think they pay that counts, and " what they think they pay " depends almost entirely on their feeling that they are getting the worth of their money. In the development of the business end of the industry we have a field

of almost limitless extent, and to properly go over it would require a paper by itself. Such a paper would consider the policy of offering to the customers of the company small cooking and heating utensils on condition that the connections and fittings therefor be purchased at a nominal price, and of following soon with a second offer, to exchange these utensils for larger ones, which would generally result in the retention of both by the customer. Then comes the well-stocked store of gas appliances centrally and conveniently located, and the exhibitions given therein, including cooking by experienced cooks furnished by the company and using the modern gas range, such exhibitions to be in charge of the lady managers of the various charitable institutions of the city with the privilege to them of disposing of the food products for the benefit of their various charities. All this to be followed by a vigorous effort to supply all classes of customers with cooking and heating appliances of all kinds and sizes. And then follows the canvassing for customers, for which a commission is paid, together with the piping of houses and the sale of fixtures, thereby enabling the poor man to become a customer at an outlay of from five to ten dollars, and giving him, with the Welsbach lamp, a better, more economical, and more satisfactory light in every way than he had with oil.* And this only opens the door for an almost unlimited number of other developments, the introduction of gas engines being a very important one. For lack of space we must dispose of this portion of our subject with the remark that the valuable management for the gas works of the future will be the management that understands how to extend the business and has the ability to do it; and it will be a mission requiring lots of energy, patience, and hard work, but fully as beneficial to mankind as any in the land.

Progress seems to be the watchword in all lines of industry in the present age, and our electrical friends just at present are unusually active. Among the many startling announcements of recent date in reference to progress in electric lighting probably none seems so tangible, and has attracted so widespread attention in the scientific press, as the discovery of Dr. W. W. Jacques of Newton, Mass., of a chemical process by which electricity can be generated direct from coal.

A fair representation of these articles comes to us through the July

* At Auburn, N. Y. (population, 30,000), over three hundred customers have been secured in this way during the past two years. Many of these had their houses already piped, but nearly one hundred houses have been piped by the company, which has received during that time: for the piping of houses, $1986.52; for ordinary gas fixtures, $2,023.80; for Welsbach fixtures, $3,220; for stoves, ranges, and other cooking and heating appliances, $2,023.80. Stoves, ranges, etc., had been largely supplied previous to this time. About 30,000 feet of wrought-iron pipe of various sizes have been used during the past two years, about one third of which was for services.

number of THE ENGINEERING MAGAZINE, and the first thought of the practical man is as to how it will affect existing interests and investments. When such high authorities as Professor Cross of the Massachusetts Institute of Technology and Professor Rowland of Johns Hopkins declare it to be one of the great inventions of the nineteenth century, it certainly behooves one to give it a careful investigation.

So radical are the changes in the production of electricity by this method that one writer, on page 657 in this July number, is sanguine enough to proclaim that "dynamos will be sent to the attics, and it will be cheaper to heat and work by electricity than by fires." And similarly we find in other magazines page after page of interesting scientific enthusiasm pertaining to this particular invention, until we are constrained to give it a careful and impartial examination. The process may be briefly described as follows.

Iron retorts are set up on end in a furnace. The retorts are partially filled with caustic soda. They also contain a piece of carbon suspended from the top, and are provided with an air-supply at the bottom. The furnace and contents are to be brought up to a temperature of 400 or 500° Centigrade, and a supply of air forced up through the fused mass of soda, the oxygen from which attacks the carbon and forms electrical energy, with which arc and incandescent lights can be immediately maintained. The efficiency is said to be such that thirty 16-candle incandescent lights were maintained for nearly nineteen hours with a consumption of only eight pounds of carbon in the retort; and this is pronounced an efficiency of about ninety per cent., for the eight pounds of carbon consumed in the retort. But what about the perhaps eighty pounds of carbon consumed outside of the retort to maintain this temperature of 800 to 900 degrees Fahrenheit and the air-blast for the nineteen hours? So disposed are enthusiasts in science to exalt any new thing that this, probably the real source of the energy, is passed over in comparative silence. If we call an enthusiast's attention to this, we are told that they are on the track, and the next step will be to accomplish all of this without the aid of outside heat; which brings up the suggestion: suppose you could do this without the aid of outside heat, or, what is more probable, suppose a small portion of the energy generated—say not to exceed ten per cent. of it—could be diverted to maintain this heat and pump the air. "Then," the enthusiast exclaims, "we would move the earth; we would certainly revolutionize all existing things." "But what about the carbon consumed in the retort?" suggests the practical man. Could you not manage in some way to furnish this, or a large portion of it, without cost? And, if you could, suppose we compare the efficiency which you would then attain with the efficiency of the

modern gas works. They have the retorts set in the furnace. They are charged with carbon in the form of coal. According to scientific authorities, something more than twenty per cent. of the energy is driven off in the form of carburetted hydrogen, called gas, which can be safely and easily stored without loss or deterioration for any length of time; and the practical man claims that the other eighty per cent. is retained as follows: forty per cent. in the form of coke, twenty-five per cent. in the form of tar, and fifteen per cent. in the form of ammonia.

One-fourth of the coke, or ten per cent. of the entire amount of energy, suffices to do all the work of heating the furnaces, and the balance of these residuals, in many cases, sells for enough to pay for all the coal, and, on an average, should pay for about eighty per cent. of it.* But the scientist comes forward with an array of heat units and standard candles to prove that eighty per cent. of the energy does not remain in form of the above-named residuals, and the practical man waves him aside with the exclamation that they pay eighty per cent. of the coal bill, and that the energy which pays the bills is the right kind of energy for him; and he claims that, if he can eliminate eighty per cent. of the raw material by the sale of residuals, then he has a right to consider the entire production of the original article sought as the production of the remaining twenty per cent. of the raw material, which would show an efficiency of the full one hundred per cent. of energy. And then he calls attention to the wonderfully efficient character of this energy when utilized with the oxygen of the atmosphere through bunsen burners, incandescent lamps, and gas engines for heating, illuminating, and power purposes.

The gas engineer calls on nature twice during the carbonizing of his coal for assistance from the oxygen of the atmosphere, as has been shown under the description of the regenerative furnace; he calls again for assistance in the distribution of his product under the weight of the atmosphere, which does it quietly and effectively, unseen and unknown to most of us; and he calls again at the utilization of the product for a supply of oxygen to support its combustion, for all its various purposes of light, heat, and power, calling twice in the use of the Welsbach lamp, or for a double service, and producing at once the most economical and efficient artificial illumination yet known to man, and which may well be called "one of the great inventions of the nineteenth century." And thus he goes hand in hand with nature in all the ways of his profession, so differently from his friend, the electrical engineer, who seems at all points to be endeavoring to thwart

* At the gas works in charge of the writer, four hundred miles from the coal mines, the residuals sold pay more than eighty per cent. of the coal bill.

her, and, with his lamp, depends for his success upon his ability to oppose her. For nature abhors a vacuum.

And now comes the philanthropist, and desires to know why, under all of these advantages, the price of the product does not fall. Why are not companies formed to give it away, so that people may rise up and call them blessed? The reply might be made that, in common with other corporations that deal with the public, they are always sure of the blessing. Perhaps a better reply would be that water is free, free as the air, and stored in inexhaustible quantities at the very doors of many of our cities; and yet it costs the people of most cities more than gas. Suppose it were possible to store daylight and distribute it by night through "vacuum tubes;" does any one imagine that it could be done for nothing? It is not the first cost of the raw material that counts in a service of this nature. It is the long train of contingent expenses that rises up to swamp the enthusiast, when he attempts to move the world too rapidly. But the world is bound to move, and we are glad of it, and we hope to see the Jacques furnace improved so that it will become self-sustaining,—perhaps float off into perpetual motion. And, when this is accomplished, then we think that, in point of efficiency, it will just about begin to get into comfortable competition with the modern gas works.

THE UNDERGROUND TOPOGRAPHY OF A CITY.

By Wm. Barclay Parsons.

THE most striking development in constructive science during the last fifteen years, and the one productive of the most far-reaching results, has been the growth of tall-building construction. Until the advent of the elevator, buildings were limited to such height as could be climbed conveniently by means of stairs, and therefore buildings above six stories are of very recent date. The old buildings had a cellar, which was regarded as a sort of necessary evil and made as shallow as possible, and foundations of a very simple character. For the latter no general study of the ground was necessary, and even the dimensions of the footing courses were regulated by general custom, or left to the discretion of the builder.

As buildings commenced to grow in height, their foundations began to grow in depth, and to assume such importance, on account of the loads they had to bear, that more attention had to be given to their design, and special investigations made in respect to the underlying material.

In Chicago, where tall-building construction may be said to have been born, it was found that the soil was not capable of supporting the new great weights, and an accurate study of the sub-surface conditions became necessary. The investigation showed that the comparatively firm surface on which ordinary building operations had been conducted was a thin crust overlying a very compressible soil, and that this top crust could sustain but a certain moderate maximum load without undue settlement.

With the deepening of the foundations, people have been led to consider the utilization of the sub-surface space, so that a modern building has in very many cases two sub-cellars, and for recently-designed buildings in the city of New York even a third has been added.

Thus the elevator, which was intended to increase the height of buildings, has been the most influential agent in increasing their depth.

The purpose of this article is not so much to show the necessity for examination and study of sub-surface conditions as to show how such examinations are made and what the facts are which are thus discovered. In the first place, the engineer who is planning important sub-surface structures must go back to the time before the site was occu-

pied by the city, and learn what he can of the originally existing conditions.

We are all familiar with the characteristics of the surface of the open country,—with its hills and hollows, water-sheds and streams, solid ground and marshes. When the open country comes to be occupied by a city, the topography is modified and changed. Hilltops are cut away, valleys are filled up, steep ascents are reduced, swamps are converted into dry ground, and streams disappear. But these changes, and especially the latter, are more apparent than real, because the old surface of the ground, if filled on, is not made one with the new, and can be found even after a long period of time and easily recognized, if sought for. Streams and their drainage areas are the most striking features of surface topography, and with the building of cities the streams do not pass out of existence, though they may disappear from sight. Although the streets are paved and all house drainage and apparently all the surplus water are carried away by sewers, nevertheless enough rainfall finds way through leaks in the pavement, through unpaved yards, or through the public parks, to furnish a considerable volume of water, which flows underground along the lines of the old streams.

And so with the swamps; although a swamp may be filled in and converted into what is to the eye, and, in fact, to all ordinary purposes, solid ground, nevertheless it still exists as a partially compressed, but still further compressible, sub-stratum, so that, if the engineer were to treat the locality according to what it appears to be, he would soon find out his mistake.

As a first step, therefore, in sub-surface investigation, the engineer should have before him some description showing what the original surface was and wherein that surface in its topographical features differs from the surface as presented by the city.

Taking New York as a type, the accompanying map (Fig. 1) represents that portion of the city lying south of Fifty-ninth street and Central park, with the streets as now laid out, the original indentations of the shore line, the old streams and ponds, and the high ground. The changes that have been made are very great and easily seen. The river fronts have been built out to a distance, in some places, of several hundred feet. Every stream and body of internal water has been converted into dry ground, and yet these changes are but superficial, for the old shore line and river bottom are still to be found; the swamps have been compressed, but not removed; while the streams, as has been said, still continue to flow as they have done for centuries, along their old courses to the rivers, and on to the sea.

There are two methods of ascertaining the composition and struc-

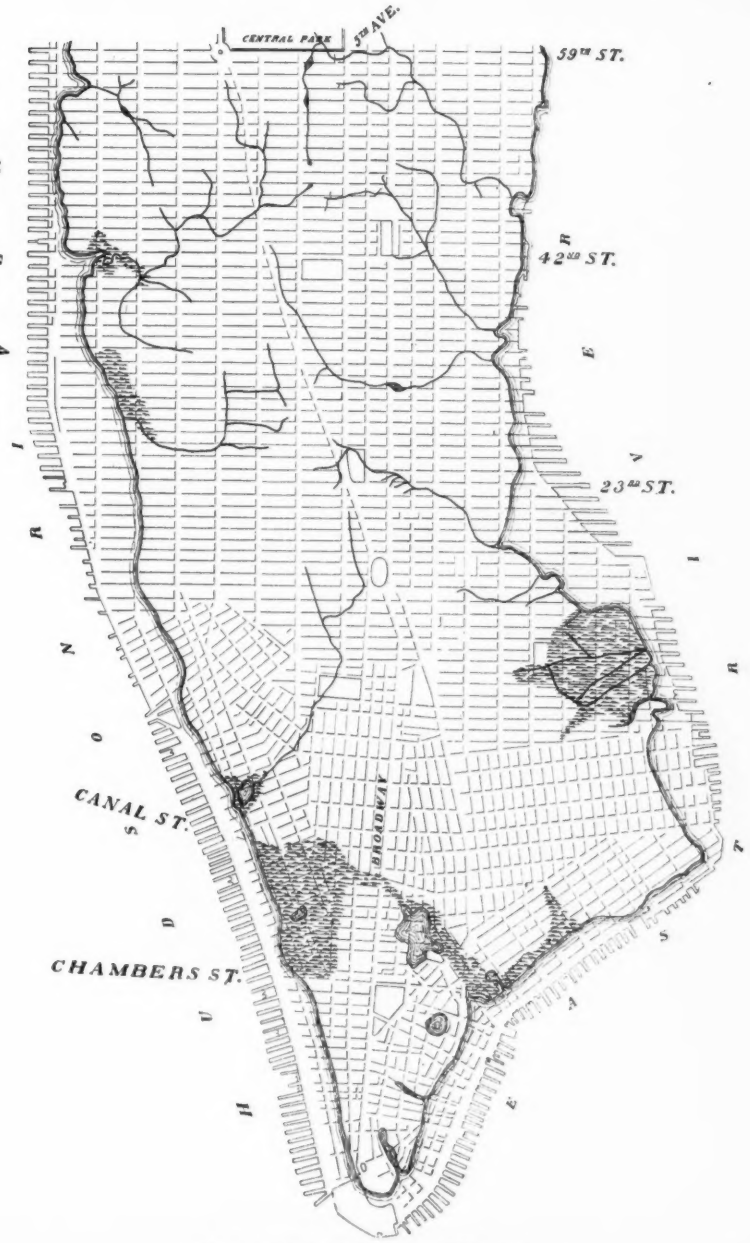


FIG. 1. MAP OF PART OF NEW YORK CITY.

Showing old topographical features and modern changes.

ture of the underlying material,—some sort of driven-well arrangement applicable to soft ground, or the diamond drill for rock. The simplest style of the former, and the one generally used for such work, is known as the "washpipe." This consists of a wrought-iron pipe about two inches in diameter, the first length of which is driven a few feet into the soil by hand, after which a smaller pipe about ¾ inch in diameter is inserted. This small pipe has its end drawn down to a flat or round nozzle, a pressure pump is connected with the upper end, and then water is forced down, which, rushing out of the nozzle into the ground, stirs up the particles of sand and carries them with the ascending current up and over the top of the two-inch casing. The casing then settles by its own weight, or else is forced further down by blows of a small portable machine, like a pile-driver. In this manner the tubing can be driven to a considerable depth, additional lengths being connected by ordinary sleeve-couplings. The material, as it is raised, can be caught and the water drawn off; and from the samples of the underlying soil thus secured the exact composition of the ground and any variation in it can be determined and recorded. By sinking holes at close intervals a very complete story of the sub-surface material can be obtained. If the pipe reaches rock or other hard substance, it can be driven no further, and, if it is necessary to determine accurately what that hard substance is,—whether a boulder, a thin layer of rock, or rock in ledge,—recourse must be had to the diamond drill. This instrument is a large boring machine, the drill of which is a hollow steel tube with an internal diameter of about one and a half inches, its edge set with pieces of cheap diamond, which wear away the surface of the rock and cut out a round core that can be raised to the surface. This core will show the structure of the rock, its composition and strength, and the presence of flaws.

The level of the ground water can be measured by dropping a line down through the two-inch test pipe, before it is withdrawn. In locations near tide or other bodies of permanent water, and in a porous soil, the level of ground water is approximately that of the main body, but it will rise above it according to the non-porosity of the soil. In this matter, which has a very strong bearing upon any engineering construction, the engineer has to be on his guard against pockets of water, or water held back in the soil by a sub-stratum of clay or other non-porous soil, which, if unexpectedly tapped, is apt to burst forth and do considerable damage.

In the construction of high buildings there is required a knowledge of sub-surface topography; it must be known whether the ground is made or natural, whether flowing water is present, what the level of ground water is, and of what the underlying material is com-

posed. But such investigations, important and necessary as they are to the locality, are usually too far separated to give a sufficiently connected series of studies, by which all the variations and conditions can be noted and the sub-surface topography portrayed as a whole. Such a study can be made only through test holes set close together and covering an extended area, and such investigations are apt to be made only along a line of streets in connection with some municipal or railway work.

An investigation of this character was undertaken in New York by the rapid transit commission of 1891, when an underground railway was laid out along the line of Broadway. By means of washpipes test holes were sunk at every street intersection along the route, and the material carefully sampled. From these samples it was easy to determine the depth at which any variation in the sub-soil occurred, and so construct a profile, or rather a vertical section, a portion of which is shown in Figure 2. This illustration indicates what would be the appearance, if a cut were made the length of Broadway and one half of the street removed. It will be seen that the surface of the street is no indication whatever of the existing sub-surface conditions. Rock is further down where the surface is highest, the configurations of each stratum do not always conform to the rock or surface line, and the several kinds of sand have their hills and hollows as sharply marked and as easily distinguishable as the hills and hollows of the open country. In the profile in question, while the quality varies, the material is all sand and porous. But suppose one of the layers were clay, or that a thin seam of some such non-porous material occurred ; then these strata would have an additional interest as indicating the line of flow of underground water, and the possible existence of pockets. In the porous soil in question the level of such ground water is nearly horizontal and but a short distance above high tide, which is indicated by the straight line.

There was a time when what is now the Hudson river, instead of flowing into New York bay, flowed into the Atlantic ocean some eighty miles further away, and when the rocks of the lower part of what afterwards became Manhattan island stood many hundred feet higher than the rock line shown in the section. The reader can picture to himself the great glaciers which followed, and which, after grinding away the hills, left the rock surface ploughed with the deep furrows that we find now ; and then the slow deposition, by other glaciers and ice caps, of the sand strata, results of their destructive action elsewhere ; and so the building of that structure, layer by layer, on which some day was to be built the very heart of the metropolis of the western continent.

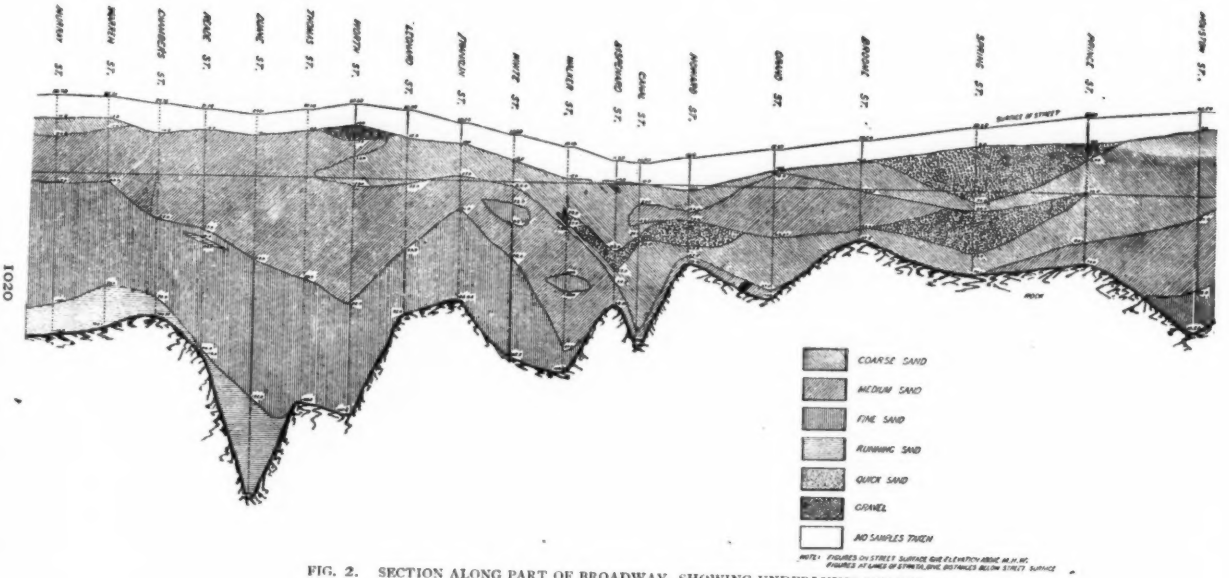


FIG. 2. SECTION ALONG PART OF BROADWAY, SHOWING UNDERLYING STRATA.

What is shown here of New York, both in the section and in the map, is but typical of other cities. The surface as existing differs from what the aborigines or even the oldest inhabitants knew,—a soil overlying the bed rock at various depths; configurations of the rock and surface not necessarily having any relation one to the other; the soil composed of layers of different materials, and these layers existing in all sorts of shapes and frequently with a sharp line of demarcation; and the streams still flowing, but with diminished volume, in their old channels, although covered perhaps by many feet of filled-in material.

In addition to the natural, the artificial features are as strongly marked, and, for practical purposes in the carrying out of construction work, equally important. Underneath the streets of large cities are laid pipes for water, gas, steam, and air, electrical subways, sewers, and other similar structures necessary in modern urban life. All of them, except the sewers, are laid without much regard for topographical questions, but the sewers must to some extent follow original

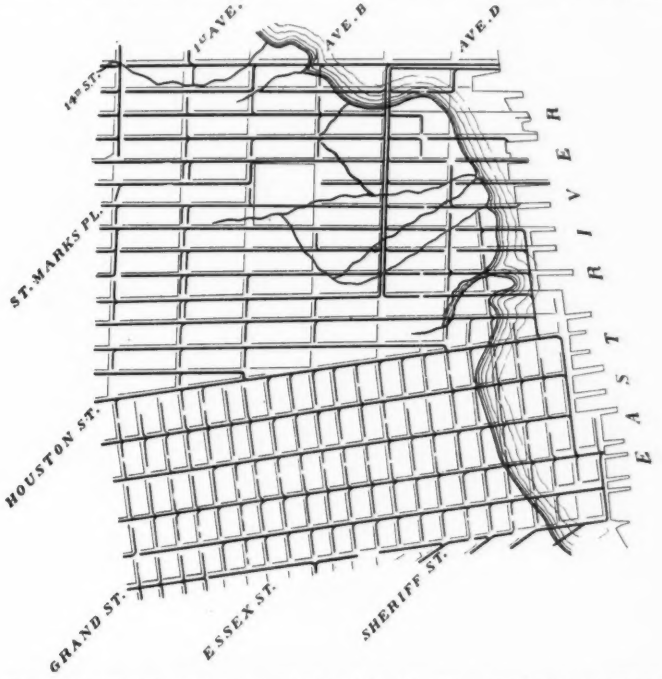


FIG. 3. PART OF NEW YORK, SHOWING OLD WATER COURSES AND MODERN DRAINAGE.

drainage areas, unless the sewage be pumped. These sewers, therefore, are, in fact, artificial brooks and streams, and, by carrying the larger part of the rainfall and all of the house-drainage, are intended to supplant the original water-courses. They start—or rise, as would be said of brooks—along the edge of the divide which separates one sewerage district from another; follow along the streets in small pipes; then form junctions with two or more, the pipe being increased to a brick sewer; and then pass on, growing in size and volume of flow, picking up other branches and feeders, just as the stream is fed by small brooks, until at last a number of sewers are gathered into one large trunk sewer, in which there is at all times a steady flow, and so on to the outfall in the sea, or other point of disposal. Now, these artificial streams with their divides, although in large measure similar to the natural streams, which they have displaced, frequently differ from them in detail of location; and so beneath our feet in any large city it can be said that there are two distinct systems of drainage,—the artificial system made by man, following straight lines and to some extent regardless of the surface or subsurface topography, and the system laid out by nature, which, though largely supplanted by that made by man and buried out of sight by him, still struggles to maintain its original independence. Figure 3 is a map of a small portion of the city of New York, showing the position and direction of flow of the sewers and the approximate location of the old water-courses.

Were it possible to take up the surface of the street and its immediate underlying soil, or, rather, if a photograph could be taken by Röntgen rays, we could get a picture of which the illustration in Figure 4 is an example. Since that diagram was made in 1890, the horse-car railway has been converted into a cable road, and two lines of cable yokes have been added to the pot-pourri, and yet the tangle of pipes and sewers shown at the intersection of Fulton street and Broadway is typical of what may be found in any great city, and in intricacy and number of pipes is exceeded, in New York, in many locations. Now, these pipes and the other sub-surface structures are quite as important a part of underground topography as the rock and the other material that go to make up the soil. In doing work the latter can be removed at will, but these pipes are to the city what arteries and veins are to the human body, and cannot be rudely or arbitrarily displaced; whatever is done to them has to be carefully planned out beforehand, the cut ends plugged, and a continuous circulation in some way secured, with a skill similar to that displayed by the surgeon.

The study of underground topography has an interesting aspect, when considered in connection with a city like New York. How

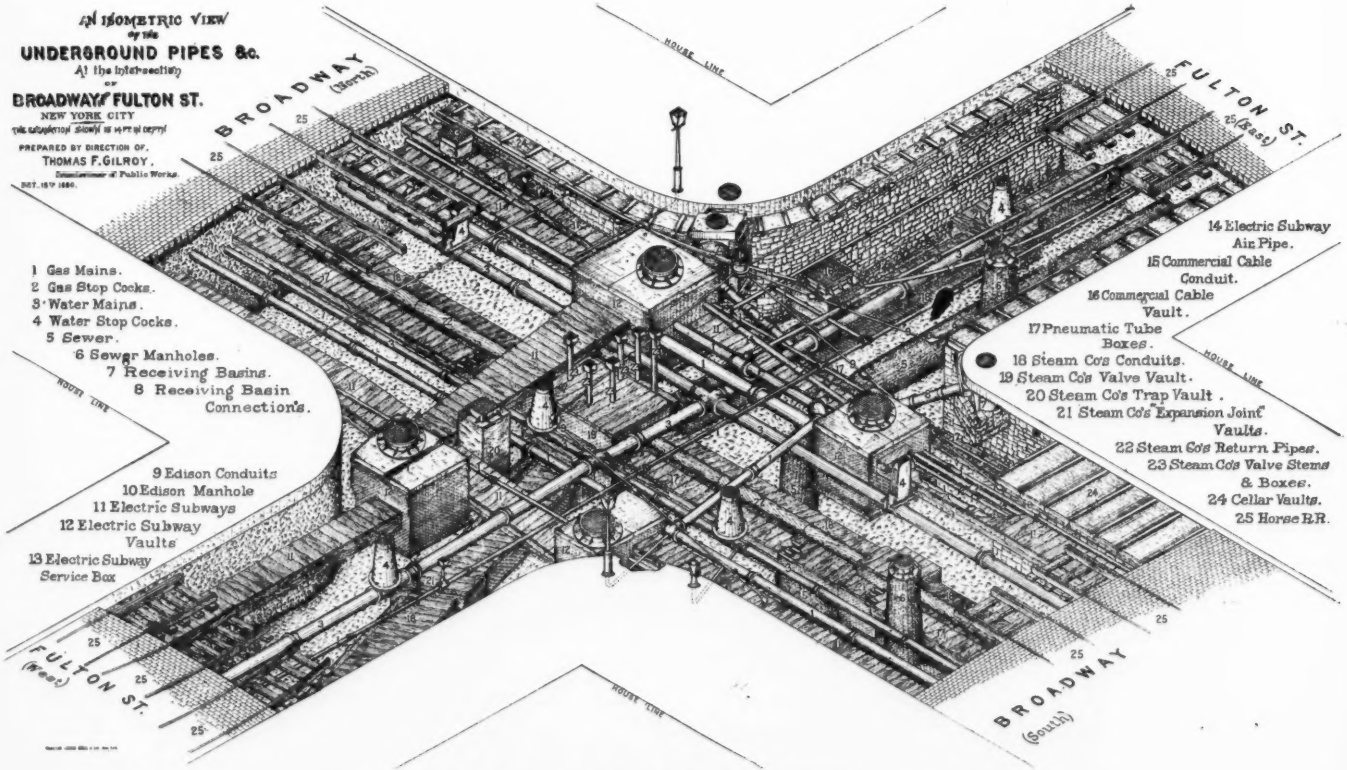


FIG. 4. WHAT IS UNDER THE SURFACE AT BROADWAY AND FULTON STREET, NEW YORK.

much more interesting is it when taken in connection with one of the cities of the old world! In the construction of the underground railways of London, a very complete view was had of the underground topography, which is described as follows by Sir Benjamin Baker, the engineer.

"When a tract of country is closely covered by buildings of varying heights, and the natural water-courses are converted into covered sewers, it is difficult to form a general idea of the physical features. In the case of the metropolis, however, a sufficient record exists of the previous condition of the country, where the excavations have, in many instances, offered an interesting confirmation of traditions.

"It is believed by competent authorities that, long before the Roman Invasion, some Celtic chieftain settled in the 'City' and called his place of business 'Lynn-din,' the Fort of the Lake. However this may be, it is certain that in early historical times the little hill on which the City stands was fronted by a wide stretch of tidal marsh land, extending to the base of the Surrey hills, and was flanked on the east by the Wall brook and on the west by the Fleet river. Between the City and Westminster, the river overflowed its northern bank to only a limited extent, but westward of that it extended inland for at least a mile, forming the swamps of St. James's Park, Pimlico, Fulham, and other low-lying districts now traversed by London railways. To the north extended the rising ground culminating in the heights of Hampstead and Highgate and the lesser heights of Campden Hill, Notting Hill, Maida Hill, Primrose Hill, Haverstock Hill, and Pentonville Hill. Between the different spurs of the northern range of hills are drainage depressions, formerly clear-running brooks or tidal channels, but now polluted sewers, with tidal flaps for storm overflows.

"To the west of Kensington and Chelsea, rising in the high ground, but traversing chiefly the low-lying district, was the Bridge creek now known as the Counters creek sewer. Proceeding eastwards, the next stream met with was the West Bourne, rising on the western flank of Hampstead Hill and flowing southwards to the Serpentine, and thence into the Thames, near Chelsea bridge. This is now called the Ranelagh sewer. Next in order was the Ty-Bourne, which flowed from Hampstead through Regent's park and thence, by Marylebone lane (whose strange windings are due to the houses having originally been built on the banks of the stream) and by the Green park, to the river between Vauxhall and Chelsea bridges. No stream of importance existed between the Tybourne and the Fleet.

"The historical stream, known for the first part of its course as Hole-Bourne and for the latter portion as the Fleet, flowed from the

Hampstead and Highgate ponds due south, passed King's Cross and along a deep tidal inlet into the Thames at Blackfriars bridge. The sudden dip in the roadways at Holborn Valley and at Ludgate Hill remains as evidence of the former existence of this useful tidal navigable channel. Though a benefit in olden times, it is hardly necessary to say that the Fleet river, converted into a huge sewer, constituted a serious difficulty in the construction of the underground railway. As regards the character of ground cut through, a considerable depth of made ground would necessarily be looked for at the east end as the line as carried through a City founded perhaps two thousand years ago and ravaged and burned by the Celts, Romans, Saxons, Danes, and Normans. In places as much as twenty-four feet of ruins and dust were cut through. At the mouth of the Fleet the chalk rubble foundation of an old fort was exposed, and at the Mansion House a masonry subway was discovered intact. Similarly, at Westminster made ground was found to a depth of eighteen feet. Remembering that between the City and Westminster the line was carried along the old bed of the river, mud and silt would naturally constitute the chief part of the excavation. The cuttings of the railway show that, if what Sir Charles Lyell called the great ochreous gravel deposit of the Pleistocene epoch were swept away, the hills and valleys of the metropolitan area would be practically unaltered in appearance. At what period in the remote past the sand, gravel, and brick earth cut through by the railway were deposited, no one can tell. It is believed, however, that England was then united to the continent: that the present site of the North sea was dry land, and the Thames a tributary of the Rhine. It is proved by the remains of animals swept down by floods and buried in the gravel at Windsor, Kew, and London, that roaming about the valley of the Thames must have been the mammoth woolly rhinoceros, hippopotamus, straight-tusk elephant, lion, elk, bison, horse, bear, wolf, reindeer, and other animals. Was man existent at this epoch? It is very generally believed that he was."

If nothing else has shown it, then certainly this extract will show that apparently so simple a thing as digging a hole can have its poetic side, and that the very ground underneath our feet has a story to tell, and an interesting one too, if we would take the pains to read it.

Space has three dimensions, but, as far as cities are concerned, it also has three divisions,—the surface, above the surface, and beneath the surface. The first is already occupied, the second is fast being penetrated by high buildings, and the third is yet to be developed to its full possibilities. It is not so long since no one thought of using the third for any purpose for which either of the other two would do, and only pipes and sewers which could not go anywhere else were

placed underneath the surface and buried in trenches, generally without systematic arrangement and certainly without any means of access except the barbarous one of again tearing up the surface of the street. The space above our streets has been filled with telegraph poles with their network of wires, supports for elevated railways, and other obstructions, while the surface has been occupied by power-driven railways of some sort. Although the telegraph wires and poles have been banished to the third estate, the other obstructions remain.

At the outset it was stated that high buildings had introduced new problems, in addition to their own, and these flow from the placing of an increased population upon a limited area and the greater demand, not only for the old necessities of water and gas, but also for more of them, and for steam, electricity for all purposes, air, and, above all, for greater transit facilities. It takes time to educate the public to any radical change in habits, and therefore they are slow to make use of new resources, however advantageous.

In Europe, where greater surface congestion has obliged the people to look for relief in other directions, the sub-surface space has been utilized for the construction of railways and subways, in which pipes

TREMONT STREET, BOSTON.—AS IT IS NOW.

TREMONT STREET, BOSTON.—AS IT WOULD BE WITH AN ELEVATED ROAD.

and sewers can be systematically arranged. The work recently completed in Baltimore, that proposed in New York, and that actually in hand at Boston, indicate that soon in this country, too, the development of the space beneath the surface will be increased in a measure more adequate to the rapidly growing needs of our cities.

The greatest step in this direction is the Boston work, undertaken to relieve Tremont street of its intolerable congestion of trolley cars. The first proposition was to do so by means of an elevated railway, but better counsels prevailed, and an underground railway is now being built to accommodate the ordinary street cars.

In the illustrations on pages 1026, 1027 and 1028 are three views of Tremont street, as it is, as it might have been, and as it will be. These pictures, all taken from the same point of view, showing that busy thoroughfare restored to its proper usefulness, relieved from its present burden, and saved from a worse fate, tell far stronger than

TREMONT STREET, BOSTON.—AS IT WILL BE WITH THE SUBWAY COMPLETED.

words can of the possibilities contained in that study which leads to the fuller development and use of the space, now almost entirely wasted, underlying a great city.

THE LESS-KNOWN GOLD FIELDS OF COLORADO.

By Thomas Tonge.

THE celebrity of Cripple Creek is due as much to the phenomenal advertising it has received as to the wonderful richness of the district. Its meteor-like brightness has dazzled and practically monopolized the attention of persons at a distance, causing them to overlook the fact that there are a score of gold-producing counties in Colorado, including many new districts of undoubted merit, fully recognized by practical mining men, though little heard of by people at a distance.

If those who read this article have access to a recent map of Colorado, it will be noticed that the older and thoroughly-established mining-districts constitute a well-defined, broad belt through the State, practically following the mountains from Boulder county in the north to La Plata county in the south-south-west. This broad general belt contains the celebrated mining districts of Boulder, Gilpin, Clear Creek, Park, Lake, Pitkin, Chaffee, Gunnison, Hinsdale, Ouray, San Juan, San Miguel, Dolores, and La Plata counties, there being considerable intervals between the well-recognized mining districts.

The depression in silver mining several years ago closed many mines in Colorado, and threw thousands of miners, ore-haulers, and others out of employment. The increased demand for gold, and the unexpected discovery and development of Cripple Creek, caused such unemployed men and many others to prospect for gold. The result has been to demonstrate that the gold-bearing belt of Colorado is not only longer and wider than was supposed, but also more continuous, —that is, in the intervals between the well-recognized mining districts gold-bearing formations have also been found.

As an illustration, a brief account of two visits recently paid by the writer to one of these new districts—*viz.*, the gold belt of Gunnison county—may be interesting. Gunnison City (7,680 feet altitude), the most convenient point from which the southern end of the new belt can be reached, is 290 miles from Denver *via* the Denver & Rio Grande Railroad, crossing Marshall Pass (10,852 feet), and 200 miles *via* the Denver, Leadville & Gunnison Railroad, crossing Alpine Pass (11,596 feet).

The first visiting party consisted of a well-known geologist, an assayer and mineralogist, a practical mining man, and the writer and

GUNNISON CITY, COLORADO.

his wife. Utilizing light spring wagons, we occupied eight days in thoroughly investigating the geology and mineralogy of a tract of country about 25 miles long by about 15 miles wide, having an average altitude of that of the Hospice of St. Bernard, Switzerland, the highest inhabited point in Europe,—*viz.*, 8,200 feet,—this tract of country, with an area of over 500 square miles, having as yet a population of only about 500 persons, mostly in small "camps" of log cabins.

The country consists of a series of bare rolling hills, much resem-

THE EXPEDITION.

bling Cripple Creek, with occasional scattering pines on the summits, the dividing gulches having a fringe of willows along the damp bottoms. The climate is much milder than that of the same altitude in Switzerland, as this new gold belt has been for years a good grazing country, where cattle and horses forage for themselves all winter.

The region is composed of schists underlaid by granite, both being traversed by dykes of eruptive rock. The schists are traversed by a network of quartz and feldspar veins, many of which are but local. Others are fissure veins of all sizes, from a few inches to ten to fifty feet wide, traversing the region for miles in a generally east and west direction. Their value, so far as at present prospected, is low grade.

THE CEBOLLA VALLEY; ALTITUDE 8,200 FEET.

Besides quartz veins in schist, feldspathic dykes, and eruptive granites, there are true eruptive volcanic dykes and volcanic overflows. In some respects the district geologically resembles Cripple Creek.

The trip was a most enjoyable and interesting one, including a visit to the romantically-located Cebolia Hot Springs (altitude, 8,200 feet), and an inspection of the wonderful mountains of iron and manganese at Cebolla, 800 and 1,000 feet above the level, their base covering 800 acres. From base to apex there are cuts, tunnels, and shafts in solid ore. Some of these are more than 40 feet in solid mineral, and in no place has the bottom or limit of the ore been reached. About one-third the area is manganese, 25 per cent. pure,

OPEN CUT IN SOLID IRON ORE.

the remaining two-thirds being hematite, averaging 55 per cent. metallic iron.

As a known gold-mining possibility the district is less than three years old, the inhabitants being mostly from silver-mining districts, possessing as capital only experience and muscle, and therefore unable to develop their claims beyond the windlass stage. For lack of capital, there are as yet less than a dozen developed properties in the entire district, the very deepest being only 200 feet.

A TYPICAL MINING CAMP.

Two of these may be mentioned, as examples illustrating the situation. In one case two prospectors last summer found and followed an outcropping, sunk, found a vein of gold-bearing quartz, pushed work, exhausted their means, got financially embarrassed, and were unable to proceed. A successful and experienced Colorado mining man with capital came along, made careful investigation, acquired the property, —a group of eight full claims,—formed a private company, erected a hoisting plant, sunk a new shaft 190 feet deep, ran 1,500 feet of drifts on a vein of white, gold-bearing, free-milling quartz of an aver-

THE BEGINNING OF A MINE.

"MERELY AWAITING CAPITAL."

age width of five feet, and erected a 20-stamp mill and a pumping plant, the total capital invested being $75,000. The results are: over 70 men at work; 70,000 tons of ore already in sight, which can be mined and milled at a cost not to exceed $3 per ton, leaving an average net minimum profit of $10 per ton, or $700,000 net, now in sight for an outlay of $75,000, to say nothing of the further extensions of the vein not yet opened. Within a radius of several miles of this property there are dozens of claims belonging to impecunious prospectors, where the surface indications are as good as, if not better than, were those of the group in question when the present owners took hold, the inference being that a similarly judicious expenditure of capital would produce similarly satisfactory results.

The second case is a group of sixteen claims comprising a dyke of free-milling, mineralized granite 300 feet wide and already traced 1,800 feet long, said to carry from $4 to $20 of gold per ton. The principal owners are two gentlemen in Wall street and an American banker in Paris. There are numerous shafts, open cuts, etc., on the top of the hill, exposing the ore matter, but it is proposed to tunnel in 1,000 feet several hundred feet down the slope of the hill, and tram the ore down grade to a point on the river, less than a mile distant, where a large stamp mill will be erected as soon as practicable, thus enabling $6 ore to be mined and treated at a profit. The apparent vast extent of the ore body would indicate that this may make one of the big mining properties of the State,—something like the great low-grade Treadwell mine in Alaska.

The other partially-developed properties of the district represent capital from Aspen, Colorado Springs, Cripple Creek, San Juan, and other places in Colorado, and also from Iowa, Missouri, etc. In the wide intervals between such properties, the country is more or less dotted over with promising prospects, as yet in the hands of impecunious locators unable to proceed further with development. The geologist of the party, in his official report, says he knows of no young district which offers a better field for intelligent investigation and judicious development.

Our visit to the northern and older end of the Gunnison gold belt embraced a wagon journey of 190 miles and the personal inspection of scores of mines and less-developed properties.

The triangle of country, two sides of which are bounded by Ohio Creek and Quartz Creek, and all parts of which are within a few miles of the town of Pitkin (altitude, 9,200 feet) on the line of the Denver, Leadville & Gunnison Railroad, is very well worth the personal investigation of capitalists. The geological conditions are all that can be desired for a gold district, consisting of granite, schists, etc., traversed by dykes of porphyry, and other igneous rocks and strong quartz veins. The only extensively-developed mine in the triangle is the Sacramento, in which the ore body is continuous and well mineralized, remarkably even in character. The property is developed by over 5,000 feet of tunnels and levels, the ore ranging from $20 to

"THE DAY SHIFT," MINE TWELVE MONTHS OLD.

$300 of gold per ton, the production to date being nearly $300,000.

What has been and is being done at the Sacramento can apparently be duplicated at fifty other properties in this triangle, the only question being one of capital. At the surface the ore is quartz, containing oxidized iron and free gold, and, as depth is gained, it becomes a sulphid. It is within the mark to say that about a dozen mines within a few miles of Pitkin, with judicious management and a moderate amount of capital, could at once, or in a very short time, ship gold ore and pay dividends. There are scores of less-developed

SACRAMENTO MINE.

properties which need only capital to put them in the shipping list.

It is gratifying to know that, besides Colorado capital, outside money is beginning to find its way in from Boston, New York, Chicago, Pittsburg, Iowa, etc.

Pitkin was a great silver-producing district prior to 1893, and the Cleopatra and Fairview mines (altitude, 12,000 feet) compare favorably with the very best mines of Aspen and Leadville, as, owing to the extreme richness of the ore, they have never ceased shipping. If silver is remonetized, Pitkin will enter upon an era of great prosperity. In Chicago Park, near Pitkin, a few years ago, two holes

PITKIN, FROM CHICAGO PARK.

were bored nearly 1,000 feet deep, penetrating much the same strata as at Aspen, but revealing three rich ore zones instead of one. The fall in silver in 1893 prevented shafts being sunk at the bore holes. Within a short distance is a similar basin,—Hall's Gulch,—where bore-holes revealed equally good prospects. Such investigation demonstrated the fact that in the vicinity of Pitkin are two of the largest silver-ore basins as yet known in Colorado, both practically virgin ground.

Between Pitkin and Tin Cup (altitude, 10,200 feet) are a number

CLEOPATRA AND FAIRVIEW MINES; ALTITUDE 12,000 FEET.

BRUNSWICK MILL AND JIMMY MACK SILVER MINE (CLOSED DOWN).

of silver mines now shut down by the fall in the price of silver, including the Jimmie Mack Mine and Brunswick Mill, representing about $180,000 of New Jersey capital; the Gold Cup group, representing about $350,000 of New York and Colorado capital; the Tin Cup mine, owned in Kansas City; El Capitan mine, owned in Illinois; the Carbonate King and Queen, owned in Kansas City and New York; the Iron Bonnet mine, owned in New York; the Napoleon, owned in St. Louis, etc.

There are to-day more men at work in the Tin Cup district than

TAYLOR PARK.

ON FOREST HILL; ALTITUDE 10,500 FEET.

in the Pitkin district, many of them being employed in the placers in the vicinity of Tin Cup, which are very rich and have been worked for many years, though only by hand,—that is, without any appliances involving the investment of considerable capital.

North of Tin Cup is Taylor Park, an undulating, grassy valley,

MINE ON CROSS MOUNTAIN; ALTITUDE 12,200 FEET.

THE MILL AND CABINS, CROSS MOUNTAIN; ALTITUDE 10,000 FEET.

THE LIVING QUARTERS, CROSS MOUNTAIN; ALTITUDE 10,000 FEET.

twenty-eight miles long by eight miles wide, with an average altitude of over 9,000 feet, surrounded by snow-crowned peaks ranging from 13,000 feet upwards, and drained by Taylor river and its tributaries,—all splendid trout streams. The billowy character of the park is due to the fact that it was once the site of an immense *mer de glace* fed by tributary glaciers from the amphitheatres in the adjoining ranges, and that these various glaciers deposited moraines, which now constitute the low rolling hills in the park; further, there is evidence of two distinct glacial periods with intervening lake period.

In Taylor Park, at a point ten miles from Tin Cup, we visited the headquarters of a most interesting enterprise. Massachusetts capitalists some time ago employed a noted California placer expert to examine and report upon Taylor Park. He spent several months on the ground, and his report was most favorable. To make quite certain, however, other experts were subsequently employed, and their independent reports confirmed the report of the Californian. Thereupon a company was organized with Massachusetts capital, about three thousand acres of ground were secured, and a ditch is being built from Taylor river 17 miles long, 8 feet wide on the bottom, 10 feet wide on the top, and 3 feet deep, with a fall of 15 feet per mile, carrying 2,000 miners' inches of water, the total cost of such ditch being estimated at $38,000. A second ditch is being built from Texas Creek 6½ miles long, 5 feet wide on the bottom, 7 feet wide on the top, and 2½ feet deep, with a fall of 20 feet per mile, the total cost being estimated at $12,000. It is expected to have the small ditch completed by the middle of September, and the big one before snow falls. Next spring these two ditches will furnish water for hydraulic placer-mining on an extensive scale. The lowest estimate of any of the experts as to the gold in the gravel is 25 cents per cubic yard. One single gulch, Hall's gulch, 1 mile long and 600 feet wide, is expected by the experts to yield $2,000,000 in gold, and this represents only one-tenth of the area of the company's ground. The company is putting up a sawmill, as it expects to use 339 000 feet of lumber for flumes, and 1,600 cords of lumber for riffles.

The details of the operations of this company are given, because, according to the best information that can be obtained, there are at least over 200 square miles of gold-bearing gravel in and around Taylor Park, which pans gold almost anywhere. The company representing Massachusetts capital is the first organization that has ever approached the matter with capital on a large scale. It has only a fraction of the ground, and what it is now doing others have every opportunity to do in adjoining places.

The question arises: Where did all this placer gold come from?

Strange as it may appear, although the existence of these immense placers has been known and some portions of them have been worked in a superficial kind of way for thirty years, there does not seem to have ever been any persistent or thorough effort to prospect the ground at the head of the gulches for veins. While the gold may have come from the disintegration of mineralized rock too low grade to be profitably mined, the probabilities are that much of it came from the breaking of high-grade gold-bearing veins now covered up by *débris;* and the Massachusetts company, in hydraulic mining down to bed-rock, will possibly discover some of the original veins.

We also visited Forest Hill (altitude, 11,000 feet) on the west side of Taylor Park, about 20 miles north of Tin Cup. On this hill, even to the crest, three different companies, representing Minneapolis, Michigan, and Ohio capital respectively, are operating. Very rich float has been found on the hill, but, so far, the veins from which it came have not been discovered, and the Minneapolis company is the only one that has yet found veins at all,—*viz.*, one averaging about $30 per ton, and another only just struck, averaging $60 per ton.

We also visited Cross Mountain, seven miles from Tin Cup, the developments on which are destined to have a very important effect on the district. An eastern gentleman, with previous mining experience, went to Cripple Creek in 1894 and spent some months looking for an investment, but finally, disgusted with the high prices asked, left without investing in anything, moved to Gunnison county, and eventually secured some claims at an altitude of over 12,000 feet on Cross Mountain, under lease and bond. He commenced work August 1, 1895, and found considerable ore that panned and assayed well. He put in a two-stamp Tremaine battery, and in fifteen days ran through it 151 tons of ore, the result being very satisfactory. The ore averages from $65 to $70 per ton, and he saves from 65 to 70 per cent. of the assay value on the plates. During the past winter he has continuously employed eighteen men and an assayer, there being a complete laboratory at the mine. The assayer has made numerous careful tests of the tailings from the mill, the results showing that, with cyanid, from ninety to ninety-five per cent. of the assay value can be saved; a small cyanid plant is now being erected. At the time of our visit there were 600 feet of workings, all in ore, and 1,800 tons of ore on the dump. A wire tramway will be built for conveying the ore from the mine to the mill, over 2,000 feet below, so as to dispense with the pack animals now used. The capacity of the present mill will be increased, and, by means of the cyanid plant now being erected, only the bullion will have to be shipped. The country rock is lime, the foot wall being blue lime and the hanging wall dolomite. The vein varies from eight-

een inches to seven feet in width. There are four different places on the property where a shift of men can be set to work on ore, and which apparently belong to the same ore body.

Not only is this property in an entirely new district, but, from the top of Cross Mountain above the mine, the same geological formation can be distinctly traced for miles to Fairview Mountain, where are the great silver mines,—the Cleopatra and Fairview before mentioned; yet such continuation at the time of our visit was practically unprospected and unstaked. Since our visit, however, encouraged by the success of the owner of the above-mentioned property on Cross Mountain, prospectors have gone into the district, and several very important new discoveries have resulted.

The eminent geologist who accompanied the writer in the tour through the northern end of the belt sums up the district as follows:

There is a gold-bearing area in the granite rocks between Ohio Creek and Quartz Creek near Pitkin, which promises well and already has some good mines.

There is a grand future before Pitkin and its silver basins of Chicago Park and Hall's Gulch, if silver again comes to the front.

Tin Cup also will again look up with any marked improvement in the price of silver, but the strength of the Tin Cup region lies now in its splendid and scarcely-touched placer fields.

Cross Mountain shows, as at Leadville, how a contact zone, at one point supposed to be only silver-bearing, may at another point pass into gold, and reveals the presence of a gold belt which has, as yet, been little prospected and is apparently capable of much further extension.

It is not possible in a single article to give all the encouraging things we saw, or the interesting data we collected, but, from personal examination during the two trips in question, aggregating 290 miles, the writer has no doubt whatever that, if practical men with capital would examine the district for themselves and invest their money on the business principles adopted in some of the cases quoted, the results would be highly satisfactory to the investors.

The above, however, is not the only young district in Colorado, and the point to be enforced is that eastern capitalists seeking *bona fide* mining investments on a business basis would act wisely in personally investigating some of these undeveloped districts of undoubted merit, rather than rashly pay inflated prices for properties in "boomed" districts.

THE ECONOMY OF THE MODERN ENGINE ROOM.

I.—THE PROBLEM OF BOILER SELECTION.

By Charles E. Emery.

THE elementary principles involved in the construction and operation of a steam boiler are of the simplest character, and may be deduced from the ordinary operation of boiling water in a kettle over an open fire or upon an ordinary stove. In fact, if an ordinary tea-kettle containing a little water have its cover tightly closed, it typifies a steam boiler. If the outlet through the spout be free, the steam formed will escape at atmospheric pressure and a temperature of 212° ; if the outlet be closed, the pressure will rise as well as the temperature of the water and steam, and this operation will continue until an explosion takes place, unless the steam is permitted to escape as fast as formed after the desired pressure is reached. This is accomplished, in the case of the steam boiler, by admitting the steam to the piston of a steam engine or to radiators for heating buildings, or by releasing it through the familiar safety valve. The kettle may be so placed in relation to the fire that steam will be formed at times with such rapidity as to carry water out with it ; the same operation occurs with steam boilers, and is known as "priming."

Although the principles of construction and operation of the kettle and steam boiler are the same, the details are very different, on account of differing conditions. First, as to operation : the kettle is to be boiled but a short time, and may then be removed to a cooler position in the fireplace or upon the stove, so as to permit other cooking operations to go on, while the fire, though sometimes regulated, is generally maintained at maximum intensity, so that, when little cooking is being done, there is a great waste of heat up the chimney. On the contrary, the purpose of the steam boiler is to maintain steam pressure for long periods, and to utilize all the heat in the fuel as nearly as possible. If we suppose all the holes in the cover of a cooking stove filled with kettles containing water, evidently a large proportion of the heat of the fire will be absorbed by the water in such kettles, but in different degrees. Those directly over the fire will necessarily receive the most intense heat by direct radiation from the incandescent fuel, while the kettles farther back will be heated principally by the escaping products of combustion which give up heat and are thus cooled as they approach the chimney. The rate of transfer of heat to the several kettles will decrease progressively as the tempera-

ture of the gases falls from exposure to the successive kettles. If all the kettles be united in one, the operation will be exactly the same; the greatest quantity of heat will be transmitted to the water nearest the fire, and the heating operation will be less intense as the products of combustion approach the chimney. If, as in some stoves, a direct draft be opened, making a short route to the chimney, the kettles or heating surface along the route will be heated, while other kettles or other portions of the heating surfaces over which the products of combustion are not required to pass will receive little or no heat. The heating surfaces along the route taken by the gases will be efficient, but in different degrees, depending upon the heating surface encountered and consequent cooling of the gases between the fire and the chimney, while the surfaces over which the gases are not required to circulate will be inefficient.

The underlying principles of boiler proportions may be gathered from these simple illustrations. All the heat of the fire not directly radiated to the heating surfaces surrounding the furnace is carried by the products of combustion, and represented by the high temperature of the same; and such products must be passed in immediate proximity to other heating surfaces of the boiler, through which the heat is transmitted to the water and the gases correspondingly cooled. In general, the heating surface is increased so as to reduce the temperature of the gases to the lowest point consistent with a sufficient draft. The best boilers are so proportioned that all the surface is efficient, though in different degrees,—due, as explained, to the lowering of the temperature of the gases as they move toward the chimney. There are, however, plenty of poorly-designed boilers in which, at some part of the circuit, the gases are not distributed uniformly over the heating surfaces, and in which there are short cuts enabling such gases to take a direct course, as illustrated by the stove; making the portion of the heating surface encountered efficient, but leaving large areas of the normal heating surface over which the gases are not forced to circulate, and which, therefore, are inefficient. The evaporative efficiency of such a boiler is not as high in proportion to the total surface as one in which the gases are distributed over all the surfaces with substantial uniformity.

The general features of construction of a steam boiler are: first, a "furnace," in which the fire is made; second, a "combustion chamber," for the thorough mixing of unconsumed combustible gases from the fuel with the surplus air that has passed through the grate, thereby completing the combustion; third, a large area of "water heating surface," generally formed of tubes; fourth, in some cases, "superheating surface," for heating the steam; lastly, an escape for

the products of combustion, generally a chimney of considerable height to produce the requisite draft.

The furnace may be described as a "fire-box," and is often so called, the fire being usually built upon grates directly under cylindrical boilers or inside marine and locomotive boilers. An "ash-pit" is provided below the grate. For "hand firing" of "anthracite" or "semi-bituminous" coals the construction of the furnace is simple. For externally-fired boilers, the side walls, the front about the fire door, and a low wall limiting the length of the furnace, called the "bridge wall," are fire-brick. With internally-fired boilers the fire is enclosed by metal plates in contact with the water in the boiler. For burning highly bituminous coal a fire-brick arch is arranged above the fire to prevent chilling the products of combustion before they arrive at the proper temperature for full ignition. Automatic firing apparatus is largely coming into use, particularly for soft coals, in which the grates generally incline rapidly from the fire door, and the coal, which is shoved in at the front by some form of feeding device, is gradually worked down the grate by a slight movement of alternate bars effected by a small engine. In one form the coal is mechanically pushed up from below, and in another the air is admitted from above and drawn downward through the bed of coal lying upon grates formed of pipes containing water. Each of these forms has a special value for burning particular kinds of coal.

The "combustion chamber" may be wholly or partly in the furnace proper above the fire, or may be partly a chamber in continuation of the furnace, which is frequently turned upward, forming a so-called "uptake," or large passage connecting the furnace with the tubes.

The tubes of land boilers generally run horizontally through the lower portions of the shells of "cylindrical boilers," or vertically through the water in "vertical tubular boilers." In "marine boilers" tubes of different sizes are employed. The products of combustion pass from the upper part of the furnace, forming a combustion chamber through large tubes called "flues," thence through a connecting chamber or uptake to smaller tubes, and thence by another connection or uptake to the chimney. This is called a "return tubular boiler," and in some cases several returns are employed. In some forms of marine boilers, and in land boilers of the sectional type, the products of combustion are passed across or along tubes containing water. In marine boilers such water tubes cross large flues, generally rectangular, arranged inside an outer shell. In sectional boilers the tubes are collected in headers, which in turn connect at either end to drums in which the water-level is located. In boilers

of this kind the gases are directed over different parts of the heating surface by means of fire-brick partitions. In some cases such gases are required to cross long tubes several times before reaching the chimney, or to make several circuits back and forth along the tubes between fire-brick partitions laid upon the same.

In some boilers the escaping gases pass through tubes or flues, or between tubes in the steam space, so as to evaporate any moisture contained in the steam, and "superheat" the steam, or raise it above the temperature due to the pressure.

The draft is usually produced by a comparatively high chimney, but at times a shorter chimney is employed, and the necessary draft induced by jets of steam or by a suction-blower in the stack. More frequently the draft is increased by forcing air at moderate pressure under the grates, by means of a fan-blower.

In order to secure the best results, the several parts above described must be properly proportioned. Definite rules for "boiler proportions" have been established for a number of years for marine boilers, and most of such rules are applicable to all kinds of boilers, but many novelties of construction, both in the internally-fired and sectional types of boilers, have been introduced, which in many cases fix some of the governing proportions, so that the existence of any rules on the subject has been entirely lost sight of in many quarters, and questions long since settled are being tried over and over again in practical work, frequently with unsatisfactory results.

We have already shown that, to secure economy, the gases should be distributed uniformly over the heating surfaces. In some of the sectional types of boilers it is exceedingly difficult to do this without so obstructing the passages that accumulations of ashes, etc., cannot properly be removed. It is, however, apparently easy to design a tubular boiler originally so that the gases will be uniformly distributed. The tubes are of the same size and of the same length, and it seems that, by properly proportioning the connections, the difference in pressure at the two ends of the tubes, caused by the draft, could be made the same, so that the same quantity of gases would be driven through each tube, and therefore uniform and consequently maximum action obtained for the heating surface employed. Frequently no attempt is made to accomplish this result, and very slight misproportions will make a very considerable difference in the efficiency. Even with very large connections, permitting only slight differences of pressure in different parts of the same, it is found in practice that in many cases more of the gases pass through the lower tubes than the upper,—a thing which has been overcome to some extent by putting ferrules or small rings in the ends of some of

the tubes, so as to prevent free flow of the gases to the tubes having the greater draft. The more philosophical way, however, as determined by practice, is to reduce the area of the tubes as a whole, thereby increasing the "resistance," so to speak, so that the gases cannot be readily carried by a few tubes, but are forced to distribute themselves throughout all the routes to the chimney. Moreover, with the higher resistances, small differences of pressure in different parts of the connections do not so much affect the results.

It was found at an early date that boilers built with a certain ratio of "cross area of tubes" for draft to "grate surface" did better than others of different proportions, and that, with a certain fixed relation of cross area of tubes to grate surface, the evaporative efficiency of the boiler could be pretty well forecast from the proportion of heating surface to grate surface. For anthracite coal consumed at the rate of twelve to sixteen pounds per square foot of grate, the cross area of tubes for draft should be about one-eighth of the grate. For bituminous coal one-seventh or even one-sixth the area of the grate is permissible. For marine boilers there is generally provided twenty-five square feet of heating surface to one of grate, but in different types of boilers this proportion is much varied, with results that will be explained later.

The simple rules above given apply only to the rate of combustion per square foot of grate stated, so that in all cases the proportions are better referred to the average amount of coal burned per square foot of heating surface. The grate in any case must be of such size that the desired quantity of coal, to produce the requisite quantity of steam, may be readily burned with the draft available. This may be readily calculated from the fact that ordinary boilers will evaporate eight pounds of water per pound of coal under actual conditions, and that nine pounds of evaporation, and occasionally ten pounds, may be obtained with boilers of the best proportions using the best fuel, while, with coals of less calorific value or boilers of less efficiency, the evaporation falls to seven or even six pounds. The grate is usually made of such size that nine to ten pounds of coal are burned per square foot per hour in land boilers, twelve to sixteen pounds in marine boilers with natural draft, and twenty to thirty pounds in marine boilers with forced draft, whereas in locomotives, where the size of the grate is necessarily restricted, as high as one hundred or even one hundred and fifty pounds of coal are frequently burned per square foot of grate area. The rate of combustion per square foot of grate makes little difference in economy, when the thickness of the bed of coal is proportioned to the required draft and the fire is not allowed to burn in holes or with irregular intensity at different points.

Practically, however, the fires cannot be so well attended to at high rates of combustion, and waste results. So also, when the grate is too large, thereby requiring a low rate of combustion per square foot of grate, it is difficult for the fireman to obtain a uniform fire in different parts of the grate, and holes are liable to burn through, admitting cold air above the fire, which affects the economical results.

On account of the variation in the quantity of coal burned per square foot of grate, the cross area of the tubes for draft should be such that one hundred to one hundred and twenty pounds of coal and upward will be burned per square foot of cross area. The area of the passages leading to the tubes is generally fifteen to twenty-five per cent. greater than the joint area of the tubes themselves, and, to reduce friction, generally the area of the uptake leading to the chimney is made in about the same proportion. The smoke pipe or chimney, however, need not be so large proportionally, for the reason that there is less friction in a single large pipe than in a number of small ones.

The proportion of heating to grate surface varies in different types of boilers. For the old-fashioned cylinder boilers fired externally, containing no heating surface except that of the external shells below the water line, there is generally but ten to twelve square feet of heating surface per square foot of grate. With flue boilers,—which term distinguishes horizontal cylinders upon which the products of combustion impinge externally below the water line, the gases returning through large flues,—there are usually but fifteen to seventeen square feet of heating surface per square foot of grate. For boilers containing a large number of flues or tubes the proportion of heating surface to grate rises to 22 and 25 to 1 for many purposes, and, particularly for small tubes, is increased to 30, and sometimes 40, 50, and 60, to 1. As the quantity of coal burned is practically the same per square foot of grate in each case, the quantity of coal burned per square foot of heating surface for the boilers with a low proportion of heating surface is very much larger than for those with a higher proportion ; and at first blush it would seem that the cylindrical and flue boilers would be very much lacking in economy, for the reason that all the heat in the gases would not be absorbed and a large part would pass to waste in the chimney. This is true, but not to the extent indicated by the relative proportions, for the reason that the heating surface over the fire and that exposed to the hotter products of combustion near the fire are so much more effective than that to which the products of combustion are exposed when partly cooled, as explained already in the case of the kettles. In an ordinary boiler the furnace, containing only about one-twelfth of the total heating surface, evaporates fully one-half of the water, and the remaining eleven-twelfths of the surface

less than one-half of the water. As illustrative of the decrease in efficiency rather than an exact statement, it may be stated approximately that, if five pounds of water were evaporated by the heating surface in the furnace, the remaining surface would evaporate about four pounds, of which the surface nearest the furnace and equal to the area of the surfaces therein would evaporate substantially one-half, or two pounds of water, making six in all. An equal amount of surface added would evaporate about one-half as much as that preceding, or one pound, making seven in all, and additional areas would evaporate successively $\frac{1}{4}$ lb., $\frac{1}{8}$ lb., $\frac{1}{16}$ lb., $\frac{1}{32}$ lb., and so on, so that a surface eight to twelve times that in the furnace would cause an evaporation of not quite eight pounds. This progression is somewhat more rapid than actually obtained in practice, but shows that the saving by increasing the heating surface may be so small as not to be warranted.

We have approached the "Problem of Boiler Selection" by stating in an elementary, but elaborate, manner the principles underlying the operation of a steam boiler. An article of this kind should be, in a sense, educational, and, therefore, indicate the highest aims, as well as the reasons why they may not in all cases be attained. We have, therefore, pointed out that a steam boiler should absorb as much heat from the fuel as is practicable; that, in order to do this, a large area of heating surface is necessary; that, in order to make this heating surface efficient, the products of combustion must be uniformly distributed over the heating surface, and the passages in some cases be contracted so that the gases will be forced to divide among the different routes to the chimney. These cardinal principles, as we have stated, are very much neglected. We desire, however, to further point out that, in this case as in others, there are exceptions to the general rule. We have indicated correctly the proportions which should be adopted in order to secure high economy. We now call attention to the fact that, since the passages for the products of combustion must be contracted to secure high economy, it is not possible to burn larger amounts of fuel than originally provided for without some method of increasing the draft. Moreover, the extra resistance introduced prevents prompt action in case of emergency; that is, the boiler is poorly adapted to respond to an immediate demand for a large amount of steam.

It therefore follows that boilers specially designed for economy are what is called "slow steamers," available where steady power is required and not adapted for variable power. As the power is variable in many locations, a different type of boiler is necessary, and in a great number of cases what is called a "free" boiler is employed; that is, one which will, when the draft is open, burn coal quickly and fur-

nish steam rapidly, although at some sacrifice of economy. The illustration given shows that this sacrifice is not very great, though important where economy is a prerequisite.

Originally boilers were constructed with large flues, and undoubtedly wasted fuel to some extent, but they certainly showed marvellous work in furnishing steam. A reaction occurred, and boilers were made with small long tubes; such boilers undoubtedly furnished steam very economically, when there were a sufficient number to supply the maximum demand. It was found, however, as readily explained by the table, that by putting larger tubes in the boilers very much more power could be obtained, and that the economy was so near that obtained with the boilers having longer tubes that the owners would rarely discover the difference. For these reasons most of the boilers sold regularly are of the free, uneconomical type, but they give satisfaction for the reason that they furnish the steam required promptly and without difficulty. This is true both of the ordinary cylinder tubular boilers in so common use throughout a large portion of the country, and of the sectional boilers which have more recently come into the field. Tubular boilers made free in order to supply quick demands for steam are about equal in economy to sectional boilers, but the better examples of sectional boilers can be forced farther above their rated capacity than their competitors, and are, therefore, more satisfactory where the power is variable.

The greatest success with sectional boilers has been obtained by putting in a large area of heating surface per rated h.p., and an area for draft proportioned to the heating surface. At low rates of combustion such a boiler simply does as well as other free boilers, without fully utilizing its large heating surface, but, as soon as large demands for steam are made, the boiler becomes a phenomenon compared with others rated for the same power. For high powers the gases, being greater in volume, fill the spaces for draft, and thereby make all the heating surface efficient, so that such boilers easily run at double their rated capacity, and are available through the whole range.

The subject is a broad one, but its magnitude should not discourage the reader. Some simple condition may eliminate a large number of the boilers available, so that very few need be considered in making a selection. For very small powers the vertical tubular type of boiler is best; such boilers are also made of large size, but for present purposes the larger boilers come into the general class of tubular boilers. Locomotive boilers are best suited for portable work, or where the space available makes the selection desirable even at increased cost. For larger-sized boilers used on land the selection must be made from two types,—*viz.*, tubular boilers and sectional boilers.

The form of tubular boiler almost universally employed in this country is a plain horizontal cylinder, with tubes in the lower portion and steam space above, such cylinder being set in brickwork. There are, however, vertical tubular boilers which can be used when the space available is best adapted for the same. One form of these has an interior fire-box and a large number of long small tubes communicating therewith, and is particularly designed for economy, and therefore available where the power is steady, but not for variable powers, for reasons previously explained. Another type with a small shell and bent tubes enclosed in a shell of non-conducting materials directly exposed on the inside to the heat is of questionable value for use under a large building where the protecting non-conducting shell would suggest danger from fire, but is largely employed in power stations.

The use of shell boilers is absolutely inexcusable in all dwellings and office-buildings. No matter how contracted the space, the architect should provide sufficient head-room to put in sectional boilers, the details of which are now well established. As to space, the horizontal tubular boilers set in brickwork require most, though such boilers are cheaper. The sectional boilers require more height, but, on the whole, less cubic capacity for the power developed, than any other boiler enclosed in brickwork. Where space is very much restricted, particularly in height, a greater power can be installed by the use of internally-fired boilers of the marine or locomotive type. Such boilers have been used under large buildings, as well as other forms of shell boilers, all of which are perfectly safe so long as managed properly; but, no matter how carefully the engineer and his working force may be originally selected, times of recreation and sickness either of the parties themselves or in their families will require temporary substitution of different men. Moreover, when a plant once runs smoothly, so little labor is required to keep it up that the best of men become demoralized, and occasionally dangerous conditions are established by neglect or mere oversight. The chance of accident, small as it may be, should not be taken under a building of the kind referred to. So also private owners of means should not for an instant think of taking any chances. In the country the boilers may be isolated from the dwellings, but this is not the case in many locations.

However strong these considerations may be, we cannot, in an article of this kind, overlook the fact that there are very many locations where the simple and cheap tubular boilers will answer every purpose. Manufacturers that build their own boilers will, of course, put in place the ordinary type of boiler made in their own shops, and other parties will naturally take the same course by the advice of such manufacturers. For a comparatively small steam plant, where the engineer

both cares for the engine and fires the boiler, his attention is so frequently called to the latter that the risk of accident is reduced. Again, in large plants, the men operating one or two boilers have such a casual oversight over others in the same room as to reduce the risk. These considerations have their influence; so the mere question of impending danger does not prevent parties from using shell boilers, and the selection between the two types will depend entirely upon the importance attached to the different considerations above expressed.

The selection of a particular boiler from many of the same type is at times difficult for one who is not an expert. The expert knows there is little difference between them, if the work is adapted for the purpose originally, and thoroughly inspected. Those not familiar with the details can very well look over the work of the different companies on a mere business basis, and ascertain the volume of business each is doing, the kind of work the boilers are performing, and the standing of the owners as respects both business and engineering experience. It is evidently not good judgment to instal a newly-patented boiler which has not had the test of experience. There are men who will do this simply on account of difference in price and fulsome promises; so progress is not hindered by taking a conservative course and letting others have the experience. When a number of boilers are equally satisfactory, the question may be settled by the difference in price. The purchasers should, however, be satisfied, first, that they have the type of boiler they desire; second, that they have asked for bids from manufacturers of equal standing and experience; when, third, they may weigh the price with the article it is proposed to furnish.

In conclusion, we should be unfair to purchasers, and belittle the engineering profession, if we did not say that the services of an expert engineer could well be employed originally in assisting in the selection, and, finally, in determining whether the terms of the contract have been fulfilled. Perhaps the practical engineer of the purchaser may be sufficient for the latter purpose, but the various difficulties that can occur under such circumstances are best prevented by having expert assistance throughout. Advice given by contractors costs most in the end. A contract in proper form and satisfactory to one's lawyer may, if carried out to the very letter, not secure the delivery of apparatus best adapted for the particular purpose and the conditions under which operation is to take place.

For regular marine purposes the type of boiler for different classes of work has been so well established that little need be said on the subject. There has been for some time a growing desire that sectional boilers be developed for use on shipboard, and several boilers of this kind have been used for the purpose. This use, however, has

not become general; so an adaptation must be based on an investigation by one well informed on the subject. The boiler on a steam yacht is always a source of anxiety. One of the ordinary marine type and of sufficient power is so heavy that many water tubular boilers have been designed to overcome the difficulty. They are not generally as substantially constructed as sectional boilers on land, but made up of small pipes put together in many ways merely to get an enormous heating surface in a small space. Such boilers always cause difficulty in a greater or less degree, and the average yacht owner, after selecting a boiler, appears unwilling to tell of its shortcomings to other owners. It is, therefore, desirable to consult some one who has technical information as to the failures of different types, and the conditions under which a reasonable degree of success has been secured in other cases.

RAILWAY POOLING AND THE REDUCTION OF FREIGHT RATES.

By H. T. Newcomb.

THE term "pool" has been popularly, though somewhat carelessly, applied to certain arrangements between railway carriers having for their object the elimination from the cost of operation of the wastes inevitably incident to competition for traffic, and the prevention of the unjust discriminations ordinarily employed to divert business from rival lines.

Pooling contracts may be defined as those which provide for the division between two or more railways of traffic which might be carried by either, or all or a portion of the earnings therefrom in proportions set forth in the contract or determined in accordance with its terms. Contracts for the division of revenue, whether gross or net, are termed "money pools," and had existed in England for many years before being introduced in this country. "Tonnage pools" aim to secure the physical division of common business, diverting traffic from lines in excess to those which have received less than their agreed share of the aggregate tonnage. This class of pools originated in the United States, and had for its chief example the famous West-bound Trunk Line pool, which included all freight shipped to the west from New York city.

The period during which the expedient of pooling was commonly resorted to by the railways of this country began in 1870, and ended early in 1887 with the passage of the interstate commerce law, which forbade all traffic or money pools of interstate traffic. During this period the number and importance of these contracts multiplied rapidly, until at its close they had become the most conspicuous feature of the administration of the American railway system. It is not surprising, therefore, that the practice received an unwarrantably large share of the suspicion and distrust with which a large number of the inhabitants of the newer States viewed the methods of railway management then current, and an excessive portion of the denunciation and invective of those demagogues who sought to profit by that feeling, just as a few decades earlier their prototypes had profited by the popular enthusiasm for railroad construction. Though the essential principle upon which pooling is based had received the approval of nearly every intelligent student of transportation, and railway managers regarded the continuance of the system as the only effective

safeguard against general bankruptcy among railway corporations, popular distrust was victorious, and the interstate commerce law, every substantial requirement of which, save one, was clearly intended to protect the public from the ordinary and natural results of competition in the conduct of interstate railway transportation, was burdened by a provision which deprives the railways and the public of the benefit of the most successful restraint upon illegitimate competition ever devised, and is in irreconcilable conflict with every other feature of the law.

Immediately upon the passage of this law all pooling arrangements were discontinued, and there is sufficient evidence that nearly all railways sought in good faith to observe its provisions. Associations were formed with the avowed objects of securing the maintenance of reasonable rates and assisting in the enforcement of the new law. The coöperation of weaker lines was purchased in many cases by permission to charge slightly lower rates than those received by rival lines. Subsequently efforts were made to effect the satisfactory division of traffic without its actual transfer from one line to another after consignment, and without resort to the methods technically characteristic of tonnage pools; but the practical failure of these measures is now generally recognized, and the patrons as well as the owners and managers of railway properties are now urging a modification of the interstate commerce law that will permit agreements for the apportionment of traffic, when carried out under strict supervision by public authorities. This change was recommended by the sixth annual convention of State railroad commissioners in a resolution passed by an overwhelming majority; the recommendation was endorsed by a conference of representatives of the boards of trade and other commercial organizations of our principal cities, and has received the approval of individual members of the interstate commerce commission and of the author of the anti-pooling section of the present law. A bill embodying it, and including also several very necessary amendments to the interstate commerce law which were greatly desired by the commission, passed the house of representatives during the last session of the fifty-third congress, and would undoubtedly have received the support of a large majority in the senate, had not the rules of that body and the lateness of the session, combined with the obstructive tactics of a numerically insignificant minority, prevented its friends from securing a vote upon its passage.

Opposition to this change comes from those who are the beneficiaries of the present system through their ability to take advantage of railway competition in such a manner as to secure lower rates than those accorded to their business rivals, and from those who believe

that it would affect the charges for railway service in a way detrimental to the general public. The interest of the first class of opponents is so clearly antagonistic to that of the great majority, and the profits of those who compose it are so evidently the result of injustice to their commercial rivals, that they need not be considered. As no one has ever contended that the elimination of railway competition tends to *produce* unjust discriminations, it may be taken for granted that the possible exaction of exorbitant and excessive charges is the obnoxious result of pooling which is anticipated and feared by those of its opponents who are not selfishly interested in the perpetuation of a system under which they receive undue favors. That there is no substantial basis for this claim may reasonably be inferred from the rapid decline in railway charges during the period when pooling was permitted. According to Mr. C. C. McCain, for many years auditor of the interstate commerce commission and the foremost authority on transportation charges in the United States, the average rate per one hundred pounds on freight from New York to points west of the termini of the Trunk Lines was 53.7 cents in 1878, the second year of the existence of the Trunk Line pool. In 1886, the year before the interstate commerce law took effect, the average charge for the same service was 42.6 cents, and in 1892 it was 41.5 cents. In other words, during the period when this traffic was pooled the charges declined at the rate of 2.59 per cent. per annum, but, after pooling was prohibited, the rate of decline dropped to 0.39 per cent. for each year.

The following table shows the average charges per ton per mile for all traffic carried by the important roads named during the years 1876, 1886, and 1894.

Companies.	Average rate per ton per mile in cents.		
	1876	1886.	1894.
New York Central & Hudson River R. R.	1 05	0.76	0.73
Michigan Central R. R.	1.03	0.69	0.67
Lake Shore & Michigan Southern Ry.	0.82	0.64	0.59
Chicago, Milwaukee & St. Paul Ry.	2.04	1.17	1.04
Chicago & Northwestern Ry.	1.95	1.19	1.08
Chicago, Rock Island & Pacific Ry.	1.91	1.07	0.99
Chicago & Alton R. R.	1.63	0.96	0.63
Louisville & Nashville R. R.	1.85	1.10	0.88
Southern Ry.	3.46	1.93	1.13

1876 was the year of the formation of the Southern Railway and Steamship Association pool, the last year before the organization of the Trunk Line pool, and the sixth year of the Chicago-Omaha pool. 1886 was the last year during which pooling was legal, and during the

interval all the companies named were parties more or less continuously to pooling contracts covering portions of their traffic. The statement not only shows that the average decline was much greater during the earlier than during the later period, but also affords ground for a reasonable inference that it was confined to no one class of traffic, either competitive or local, but was distributed over the entire business of each company.

Those who intelligently seek the cause of this decline will not find it in competition between different railways, or even in the strife between carriers operating over lakes, rivers, and canals on the one hand and railways upon the other, but rather in the rivalry of different individuals or localities seeking to supply the same market. Constant and enormous pressure is brought to bear upon those officials whose duties include rate-making, and seemingly insignificant concessions in the price of transportation are solicited or demanded with a persistence difficult for the uninitiated to realize. A reduction of a few cents, or even of a fraction of a cent, per one-hundred pounds will often open new and extensive markets to the products of particular localities, and, if not immediately balanced by corresponding reductions in the rates from other sources of supply, may enable its shippers to monopolize what was formerly a common market. Each large shipper continuously endeavors to obtain more favorable rates than those accorded his rivals in the same locality, and thus to secure an advantage which not infrequently amounts to the difference between a gain and a loss. The use of particular commodities is often limited territorially by the freight charges from the points of production to those of consumption, and, when charges are too high on certain articles, substitutes produced nearer the points of consumption or carried at lower rates are frequently used. Similarly, the charges for passenger transportation, by limiting the distance to which agents can be profitably sent and otherwise hindering personal communication, effectively prescribe the limits of commercial interchange of commodities. Naturally, then, the entire force of commercial competition, possibly the most tremendous product of modern civilization, is found arrayed in opposition to the efforts of railway managers to maintain their charges at figures which will afford a satisfactorily remunerative return. As a result, railway charges tend constantly toward the minimum at which they will produce enough revenue to pay operating expenses and taxes and leave something—the smallest sum with which capital can be satisfied—as a recompense to those who own railway stocks and bonds. Pooling, in so far as it reduces the element of risk in railway investments and makes returns more certain, renders it possible to secure capital upon better terms. It also permits the elimination of many of the wasteful expenses in-

curred in order to keep up competition, and thus reduces the amount that must be raised from traffic to meet operating expenses. Reductions in the cost of transportation to the carriers, whether the result of new inventions, better methods, or increased traffic, invariably (for the reason stated above) accrue ultimately to the benefit of travellers and shippers in the form of reduced rates, or, what are much the same things, better facilities and accommodations. If it becomes possible to limit closely expenditure for advertising, to substitute joint passenger and freight offices and agencies for those separately maintained, to abolish commissions for securing passengers and freight, to forward traffic over the routes experimentally determined to be the cheapest, to abolish duplicate and unnecessary train service, and to effect other reforms the importance of which is apparent to every railway manager, the saving accomplished will benefit railway patrons far more than railway owners.

Industry is deprived of its just recompense quite as certainly by the improper and unjust relation between the charges for different services as by rates that are excessive. A manufacturer or jobber derives but little benefit from the fact that the rates upon his shipments, considered by themselves, are reasonably low, if those accorded his competitors are, either absolutely or relatively, still lower. Yet experience has taught the almost absolute certainty that competing railways will resort to personal discriminations in order to divert traffic from rival lines. The following extract from an article recently published in a periodical of high standing and wide circulation among railway officials indicates the extent to which this expedient has been resorted to since the passage of the interstate commerce law, and may be regarded as a statement *ex cathedra :*

" At present no railway man dares to assist the commission to information against another road. No company dares to be the active instrument in bringing complaint against another. It has its own record behind it. There would be retaliation, and (I say it with sorrow) there is no great company which can face having its record of the past years subjected to investigation with the new weapons which the Brown decision has placed in the hands of the commission."

Besides these discriminations between persons there are those between localities and between kinds or classes of traffic. These constitute a different class, because, while unjust discrimination between individuals can be effected only through secret deviations from the published schedules of charges, those between localities and commodities appear boldly in classifications and rate-sheets. The secret rates, rebates, drawbacks, under-billing, or other devices required to effect the former subject the shipper accepting and the official making them to fine and imprisonment, while the existence of the latter must be

determined by the interstate commerce commission or the United States courts, and the only final remedies are money damages and modification of the rate schedules. Even the baldest and least plausible defence will, in the hands of a skilful attorney, serve to postpone these almost indefinitely, and at least one case decided by the commission is still pending, untried upon the docket of the United States circuit court, to which appeal was made over five years ago for a decree enforcing the order of the commission.*

Unjust discriminations between localities generally result from the fact that, however closely rival lines may parallel each other, there are always many stations that are served by but one carrier. Traffic between such stations bears an unduly large portion of the general expenses of transportation, and is not infrequently forced to contribute something to even the special expenses incurred directly for the benefit of competitive business. Localities thus discriminated against find it impossible to compete with those more favored; their merchants are restricted as to the sources from which they can draw supplies, and find their sales limited to the local market; population decreases, or remains practically stationary; and natural advantages are completely nullified.

The former president of a great western railway has declared that the entire net increase in population from 1870 to 1890, in Illinois, Wisconsin, Iowa, and Minnesota, except in the new section, was in cities and towns having preferential rates, while those discriminated against decreased in population. Unjust discriminations between commodities arise either through a desire to favor a particular shipper or the industries of a particular town or section. The balance of commerce is so delicately adjusted that even slight changes in the relation of rates may create an industry in a locality where it has never previously existed, or destroy it where it has been profitable. Thus the relation between the rates charged for moving wheat and flour determines where the former shall be ground, and a considerable reduction in the rates on the raw material, unaccompanied by corresponding changes in those on its product, might conceivably transfer the greater portion of the milling business of Minneapolis to the Atlantic seaboard and Great Britain.

These evils of discrimination being the result of competition, it is evident that the success of any expedient resorted to for purposes of relief will correspond to the degree in which it eliminates competition as a factor from the administration of the railway system. Theoretically, pooling attempts to accomplish this result by making it of no

*Since this article was written, a decision adverse to the commission has been filed in the United States Circuit Court. It is understood that an appeal will be taken, which, unless extraordinary rapidity is attained, will not reach a final decision in the United States Supreme Court for several years.

pecuniary benefit to any company to receive or transport more traffic than it would obtain under absolutely equal rates perfectly maintained. This object is attained by the diversion of traffic or earnings from the companies receiving or carrying more than their agreed proportions of the pooled traffic to those which have had less than their shares. Success in securing the desired result was not absolute in the case of any pool, because pools invariably lacked stability, and the periodical revision of the allotted percentages gave an incentive for the resort to competitive methods in the hope of obtaining an increased award. In at least one pooling contract this tendency was met by a provision that no argument for an increased proportion based upon the actual receipt of more than the agreed quota during the continuance of the agreement should be given any consideration or effect. Pooling contracts, if legalized under an amendment to the interstate commerce law, will undoubtedly be made enforceable between the parties, and, as the railways generally shared in the popular belief, prior to the passage of that act, that these contracts could not be enforced by judicial process, this will constitute an additional guarantee of the continuance of particular agreements and an important practical advantage.

From the foregoing examination of the nature and effect of pooling, it is evident that, if again permitted, it will tend to reduce railway charges through the immediate substitution of more economical methods of operation and the gradual decline of the rate of return demanded upon *actual* railway investments, and to abolish unjust discriminations by removing their principal incentive. Whether pooling will accomplish these results as effectively as other means that can be theoretically devised is beside the question. It is only important that it will accomplish them in a degree that will confer inestimable benefit upon all industries, and that it is the only means of relief from the abuse of competition now practically available.

Against these advantages there is to be offset but one serious danger, and that need only be fully understood and appreciated to be prevented by public sentiment and State legislation. The danger of speculative construction of parallel and unnecessary lines is always present when money is abundant, and becomes particularly so when the existence of a pool makes it possible to levy blackmail upon several lines instead of upon a single one. Such construction ultimately advances rates by increasing the risk attending railway investments and adding to the capital upon which interest must be paid. As its imminence under pooling need only be realized to be effectively met by legislation, it does not constitute an argument against the mitigation of the more serious evils of competition, in the only way now practicable, but only for the prompt institution of proper safeguards.

THE SHIFTING LINES OF INDUSTRIAL INTEREST IN ELECTRICITY.

By George Herbert Stockbridge.

SCIENCE has its law of conformity no less than art and theology; but the only conformity it really insists upon is conformity to nature. The written laws, the creeds of science, when applied, for example, to a proposed invention, or a new problem of practice, are used against its claims to orthodoxy, or in opposition to a given likelihood only up to the moment of success. Improbabilities science may discuss, but it is dangerous for it to point out what is impossible. Till the critical moment, however the scientific creeds operate just as strictly and coercively as the creeds of theology and art. And they are the only guide.

Take, for example, the problem of perpetual motion. Perpetual motion, if it were susceptible of demonstration at all, could be demonstrated in thirty seconds. The experiment might then be discontinued and never again attempted. Still, a competent witness could tell whether the contrivance supposed to embody it had really evaded the laws which such machines had previously failed to overcome. And, if it had, so brief a trial would have been sufficient to make perpetual motion an accomplished fact, an undeniable part of scientific history. Lapse of time is not the test. The arguments against it treat that as a mere incident. The main thing—the conclusive thing up to the present time—is that perpetual motion would be a phenomenon by itself, unclassifiable in our present categories. So far as we can now see, it would contradict the order of nature. And that consideration is positive and final against it.

And yet the *perpetuum mobile*, should it ever come, would break no laws; it would make new ones. The outlaw would become the leader of the forces of order. That is the privilege of a power of nature and of human genius acting in harmony with natural law. They compel broader classifications: in science, immediately; in other departments, more slowly. We cannot exclude Shakspere from the list of tragic writers because Aristotle lived a few centuries too soon. If Spohr's "Calvary," or Beethoven's "Ninth Symphony," or Wagner's "Tristan und Isolde" are infractions of the canons, it is so much the worse for the canons. Once the steam injector is born, a law must be passed to legitimize it. You can not say, after the fact, that it is impossible for a steam vessel to cross the Atlantic. Nor will

so good an authority as Professor Le Conte, though supported by the most admirable logic, be able, it would seem, to prevent the imminent success of the "self-raising, self-supporting, and self-propelling air-ship" which he declared to be an impossibility.

I should, perhaps, have done better to select the air ship, and not perpetual motion, as my illustration, since that is even now passing from the realm of doubt and contest to the realm of fact. However, one vessel serves as well as another, so we arrive in port,—even the Flying Dutchman.

But, while science must be hospitable, inviting every new fact and admitting it with unreserved welcome, there is a period at the beginning of every science when the difficulty is to distinguish the invited guests from those that have forced their way in. Facts that are not facts are reported by ignorant or careless observers, and, where all are more or less ignorant, it is hard to be accurate with the best will in the world. This is the age of fable, the nebular period before the vaporous expansions of fact have contracted and solidified. In this period, ignorance eclipses the body of the sun, and leaves only the corona visible. Here the process of science is one of exclusion, of sifting, of selecting the kernel of truth from the mass of error. After that has resulted in the acceptance of a few facts and the construction of a preliminary theory, comes the other process of the admission of fresh facts and the gradual widening of theories and formulas.

A third stage of development has to do with the useful arts,—the sciences as applied to the benefit of the race. The development of the sciences as such is based on discovery and classification; that of the arts on invention.

These shifting stages of progress and this last-recited distinction are defined in the history of electricity and magnetism with what seems to be extraordinary clearness. The fables appear to be peculiarly fabulous, as becomes the mysterious nature of the agents. From the same point of view, the determination and the formulation of the underlying laws were and remain unequalled—certainly unsurpassed—triumphs of scientific genius. And the world does not need to be told that the embodiment of the laws in labor-saving machinery during the present century has produced effects unapproached by any other class of inventions.

To speak of invention as the embodiment—the conscious embodiment—of known laws is to beg the question from those who will have it that every great invention is really a discovery, but the facts of electrical history bear me out. Broadly speaking, the electrical arts have followed in time the period of inquiry and discussion concerning

electrical principles. A source of energy that was a subject of speculation to the ancients has received its practical application to the service of man almost entirely within the past seventy years. The force of this statement is greatly modified by the circumstance that electricity, as we best know it, was practically first discovered in the year 1800. It remains true, however, that the earliest interest in it in each of its succeeding forms was a scientific interest, and that its laws were well established before the telegraph, the telephone, the dynamo, the electric light, and the electric motor came into being.

As this paper is concerned particularly with the electrical arts, it may pass over the period prior to the end of the eighteenth century with a brief word. To that period belong the lightning-rod and certain machines for the production of frictional electricity, but no other surviving appliance of any considerable value. The first great shifting of the lines took place when the voltaic pile prepared the way for the various forms of electric battery with which we are all familiar. Here was what may fairly be called a new force,—certainly a new possible starting point for the electrical arts. It was as different from the electricity of friction as water is from ice. In place of a refractory, vixenish, eruptive, sputtering energy, the voltaic pile gave us electricity in the form of a gentle, yet sufficiently powerful, current, like a placid river,—very easily controlled and giving new and enlarged capacities to the fluid. So far as all the important electrical arts are concerned, they are built upon current electricity, first known less than a hundred years ago. They would have been utterly impossible with the electricity that Franklin knew. So great a change was introduced by Volta's marvellous discovery. The only things in the electrical arts at all comparable to it in the revolutionary nature of their effects are Oersted's discovery of the effects of an electric current upon the magnetic needle, followed by Sturgeon's invention of the electro-magnet, and the later discovery by Faraday that this same current electricity could be produced by moving a magnet in proximity to a coil of wire, or the reverse. If the voltaic pile gave smoothness and flow to the electrical element known to the last century, the production of electricity by magnetism vastly increased the power of the electrical "virtue," and paved the way for still more surprising possibilities. Electro-magnetism has been the willing servant of both forms of current, and, when the reversing of the dynamo gave us a rotary electro-magnet of great power and apt design, the recent great accomplishments of electric power were already foreshadowed.

The general situation may be stated thus: First, the great electrical inventions which have made this known as the century of elec-

tricity depend for their action on the electrical agent in the form of a current. That is, they go back to the last year of the last century, when Volta, after studying most zealously the phenomenon of the twitching frog's leg noted by Galvani, invented the modern battery as an electric source. Second, the invention of a still more powerful source of electric current, as embodied in the modern dynamo-electric machine, was prefigured by Faraday's discovery already mentioned. Third, the greater portion of the epoch-making electrical inventions of the century have been embodied in apparatus made up of a combination of one or the other of these electrical sources with some form of electro-magnet. The part played by this secondary and servile element in the development of these great arts inclines us to put the slave of the lamp before Aladdin in the building of the tower. Nothing else in science, outside of astronomy and biology, is quite so full of the beauty of adaptation as these services rendered by the electro-magnet to the telegraph, the telephone, and the electrical transmission of power.

In the order of date the telegraph takes precedence. It came some forty years after the first of its main constituent elements appeared, about half that time being required to find a tool for Volta's pile to work with. But, when, in the winter of 1819-20, Oersted discovered that an electric current traversing a wire near a magnetic needle would cause a deflection of the needle, or when, a little later, Schweigger secured increased deflections by coiling the current-traversed wire about the needle, there was at hand a tell-tale instrument which had only to be connected up in circuit with a battery to serve perfectly as the indicator of a telegraph. The needle telegraph introduced in England in 1839, nineteen years after Schweigger's discovery, was, considering the state of information on the details of construction, about as speedy a reduction of the telegraph to practice as could have been expected. To Henry, and later to Morse, the notion came of utilizing Sturgeon's electro-magnet (invented in 1825) instead of the Schweigger multiplier, and this electro-magnet, as improved by Henry and others, is the responding element of the American telegraph system to the present day.

The needle telegraph of Europe and the electro-magnetic telegraph of America held the field of electrical invention without a full-grown rival for a little more than thirty years. By the end of that time the telegraph in this country had passed through a marvellous development, and brought into existence a large public interested in electrical affairs. The establishment of the first American electrical journal, about 1874, was an appeal to this public, and no other. It doubtless filled its office, but I regret to say that, among its exclusively electrical items,

one would more frequently find notices of marriage between knights and ladies of the key than discussions of electrical resistance or magnetic lag. The prestige of having a special representative periodical belongs only to the earliest and the latest of the four great electrical arts of the century. There is still a telegraph weekly, though the original one changed its name and its character with the rise of the later arts and became a general electrical journal; and since 1889 there has been a monthly devoted to the interests of the electrical transmission of power.

After the telegraph arose two giant electrical industries, the telephone and the electric light, and later still came the electric railway and other power transmission. The first, in its generally adopted form, was another combination of the electric battery and the electro-magnet, and the second was the first great successful application of the dynamo-electric machine to the world's work on a large scale. Of this, and of the third, I shall speak later on. The one that challenges comparison with its predecessor is the telephone. Morse and Vail had taught the electro-magnet to write; Alexander Graham Bell taught it to talk.

In a certain romantic interest it seems to me that the two organizations resulting from these two different combinations of the electric battery with the electro-magnet take precedence over all the rest. Whether they are scientifically as fruitful is another question. I am sure that a competent historical romancer could weave a most engrossing tale from their history. Surely, if one takes into account the wonderful capacity of the operating agent for annihilating time and space, the unexampled subtlety of the instrument made to hand to do the agent's bidding, and the colossal changes brought about by the actual introduction of the telegraph and the telephone, nothing more could be desired. Take the electric telegraph, for example. It fed the jaded appetite of the world with a new sensation,—brought a new creation into existence. Before its time, as Professor Ayrton acutely observes, it was thought necessary for A, wishing to attract B's attention, to make a loud noise or show a large signal where A was, instead of making a slight noise or showing a small visual sign where B was. No other agency ever suggested the latter arrangement, although, since Xerxes's time and earlier, every conceivable element has been set to work to aid in securing the quick transmission of news. The door-knocker is a type that has been replaced by the push-button operating the electric kitchen bell. The former was the best that twenty centuries could do; the latter came naturally and quickly when the electric current exhibited its capacities. Indeed, the idea was suggested during the last century of utilizing the electricity of friction in a similar way.

In its turn, the telephone did something so contrary to human experience as to awaken universal wonder at its accomplishment. The mere statement is enough. Nobody will contest it. The telephone was essentially a complete novelty. It will be well to bear these unique services of the telegraph and the telephone in mind, when we come to consider the shifting of levels which has left them high and dry above the present scientific—and perhaps the popular interest.

When it came to the electric light, the field was already occupied. The light was new, but it had and still has a strong competitor in the gas light. There was no such excellence as to make anything else unthinkable, though with the telegraph that was the case, while nothing has yet appeared capable of posing for an instant as a rival to the telephone. The electric light simply took its place beside other means of illumination, and claimed its share of the business. The problems were those of subdivision and distribution, mainly, and the commercial one of finding a place for the concentrated light of the arc. That all are satisfactorily solved is evidenced by the present wide dissemination of arc and incandescent lamps.

The development of the electric motor industries, like that of the electric light, broke no new path. Good motors available for railway work and for running presses and other machinery were in existence long before the full growth of electro dynamics was reached. Humanly speaking, the world could better have spared the incandescent lamp and the two-phase motor than it could the quick intercommunication by the written and the spoken word furnished by their predecessors on the throne of electrical preëminence. If there were no trolley, we should perhaps be travelling to Flatbush by horse-car, or by steam, or possibly by compressed air; if there were no electric lights, we could do fairly well with gas; but what would supply the place of our office telephones, which enable us to talk with the business men of New York and a dozen other cities? and what would not civilization lose, should the electric telegraph become a lost art!

The growth of the telephone and the electric light side by side created an immense electrical public, forcing electricity into the foremost place among commercial enterprises on the one hand and among the sciences on the other. If there had been any doubt, however, about this being the age of electricity, it was totally dispelled by the advent of the electric motor and the employment of the electric current for the transmission of motive power. This is the latest and, in a sense, the greatest of the applications of electricity at the present time. Temporarily it eclipses in general interest all the other applications. The reduction of the giant power of Niagara to a few threads of flowing energy, for ease of transportation, and letting it

loose a hundred miles away to run a loom or a sewing machine is scarcely less than a miracle, and it is no wonder the popular interest is aroused. The apparent disproportion between the actual performance and the insignificant means employed is a never-ceasing source of wonder. Apart from its comparative novelty, and the surpassing scientific value of the art, this is the secret of the present predominance of electric power transmission in technical literature and elsewhere. This, and one thing more. It is a rapidly-growing art. There is as yet no sense of age or decay about it,—of its having reached or passed its prime. On that claim to attention the electrical arts have each in succession held the place of honor.

I have spoken of the periodical literature of electricity. Naturally, the first purely electrical periodicals touched mainly on the telegraph, and grew rapidly in interest under the stimulus of the picturesque development of the telephone and the electric light. While those two arts were in the ascendant, the journals were occupied largely with accounts of new inventions and new installations of one or the other of these appliances. Broadly, the period extended from 1876 or 1877 to 1889 or 1890. Only since the latter dates have they distinctly receded behind the electric motor.

Still more noticeably does the trend of interest show itself in general technical or scientific periodical publications and in the daily or weekly press. Within the past six or eight years several of the daily newspapers have undertaken to give their readers a column or so a week of notes on electrical progress; and every one of the scientific magazines has an electrical department as a matter of course. In these newspaper columns, and particularly in the magazine departments, the call is now for notes or articles relating to dynamo-electrics or electro-dynamics. In the magazine offices it is difficult to secure any consideration for the most carefully-prepared papers on the telegraph or the telephone. They want the latest thing in polyphase motors or the most authoritative statement about Tesla's high-frequency currents. The telegraph is out of date. The king is dead; long live the king!

The same story is told by the transactions of the learned societies. I happen to have before me the *Transactions of the American Institute of Electrical Engineers* for 1894. Barring papers on the electrical units, electric meters, and the like, which might relate as much to a battery current as to that of a dynamo, an analysis of the volume shows the following. There are five papers on polyphase apparatus or problems connected therewith; one on the electric railway and two others suggested by the action of electric-railway currents on buried pipes or other conductors; five on dynamo-electric machines or ar-

matures not included in the articles on polyphase currents ; one on the theory of the synchronous motor ; one on a certain type of incandescent lamps, and one on the general subject of the subdivision and distribution of artificial sources of illumination ; one on lightning arresters and recent progress in means for protecting against lightning ; one on the electric brake, and several other miscellaneous papers ; but not one on a subject directly connected with the telegraph or the telephone. The *Transactions* of the same learned society for 1893 and for 1895 show the same absence of discussion respecting the two subjects last-named,—and, I may add, the same putting forward of the problems and accomplishments of the larger electrical machinery. And there is no repetition of the sporadic reference to lightning protectors, as there was in 1894. Electric lighting itself had long been practically dead matter in the scientific printing-offices, till Mr. McFarlane Moore's recent experiments gave it a new impetus.

An instructive light is thrown on the shifting of relations in electricity by such a search as one is called upon to make in determining the validity of an electric patent, particularly in one of the older electrical arts. The prior art nearest to hand, and nearest, commonly, in time, is contained in the American and foreign patents. In general they are first consulted. Back of them, or concurrent with them, the scientific periodicals, the volumes of transactions, and the book and pamphlet literature. As one goes backward in the search, one notes an increasing proportion of disclosures in the literature of contrivances not found in the patents, while, on the other hand, the proportion of inventions described in the periodicals and transactions as compared with the scientific disputations gradually falls off. Starting from the other end of the circuit, we find the electrical literature of the early part of the century quite saturated with the controversy over the contact and the chemical theories of the voltaic battery. Slowly opinions on the scientific questions became fixed, and by just so much the growth of invention was apparently quickened.

This aspect of the case suggests one noteworthy shifting of the lines that has taken place inside the mysteries themselves. The character of the very priests of the cult has undergone a change. The scientific investigator has become an inventor. Experiments are now made with locked doors and with an eye out of window toward the patent office. The most famous "laboratory" in this country is Mr. Edison's factory, equipped with the most perfect contrivances for quick model-making under conditions of secrecy. Nothing invidious is meant by this. It is the spirit of the time. It accounts for the changes noted in the comparative amount of space given to pure science in the literature of earlier times and of to-day. Notably it ac-

counts for the fact that, of late years, the earliest information about an invention is likely to be found in the patents. Great commercial interests might suffer, were it otherwise. The traditions of science are preserved chiefly among the schoolmen or such inventors as were formerly connected with the schools,—for the commercial instinct has invaded them also, and dragged forth some of the brightest and best to the factory. It works better that way than it does in the reverse process. On this point I have expressed myself elsewhere in terms which I venture to quote here:

"Scientists often become inventors, but inventors rarely become scientists. Out of the large number of electrical inventors—some of them of great prominence—who have obtained their knowledge of electricity mainly from practical experience in the workshop, it would be hard to select a single example of a man who has added to the general knowledge of electrical laws and principles. This function is confined almost exclusively to those who are, or have been, laboratory workers. It may be stated broadly that the only electricians who are now devoting their attention seriously to the formulation of electrical science as such either are or have been schoolmen, and most of them bear a title indicating the teacher."

All this hints at vastly altered conditions of work for the modern scientific student,—at opportunities gained, shall we say, or lost? Gained, no doubt, in the mass; but surely some ardent searcher, now and then, would have given us more of his best work, had he not been jolted out of his natural bent by the irresistible march of the inventive spirit. Meanwhile, if it be true that the hope of advances in electrical science rests with the schools, it is thence also that future electrical inventions shall come. Not directly, but by virtue of the expansion of science which historically has preceded the rise of the arts hitherto. A new science, a new group of arts. Is it that the science of galvanism, so-called, is exhausted that it breeds no new sons? And is our increasing knowledge of the polyphase and high-frequency currents soon to give us a perfected science in that direction? The answer to these questions may furnish some hint as to the shifting lines, if such there are to be, of electrical development in the future.

THE HARMONY OF ARCHITECTURE AND LANDSCAPE WORK.

By Downing Vaux.

THE engineer and architect have succeeded the contractor and builder in the planning of bridges and buildings in America to a very great extent; indeed, it is taken as a matter of course now, when any work of this kind is contemplated, that it will be under the control of professional men; but this is not the limit of attainable improvement, nor do we yet realize, perhaps, the full advantages which can be obtained by a still wider collaboration in initial study and the complete harmony in adjusting all the elements which should enter into a perfect and effective construction.

Where the strictly architectural and engineering work ends, there is still adjoining territory more or less under control, but too often entirely neglected, or (which is possibly worse) treated in a manner jarringly discordant with the main theme.

It is true, we have grown beyond the period when we could regard with equanimity the spectacle of a castellated Gothic building with grounds whose geometrical exactness and precise symmetry recall the proverbial "Dutchman's garden"; we are no longer content that the Corinthian columns of our city hall or the Doric front of our court house should be set down in a dreary square of rain-gullied clay, or enclosed by a red picket fence.

Much of the work, in our larger cities particularly, is admirable in every respect, and we are generally learning to demand that our dwellings and our public constructions shall be given an appropriate setting: but it is frequently found, when it is proposed thus to bring the setting into harmony with the main work, that radical changes in some important feature, which could have been easily made in the beginning, are now impossible except at great expense; and the artistic effect of the work suffers accordingly.

The World's Fair at Chicago showed so clearly the success secured by coöperation between the engineer, architect, and landscape architect that we may confidently look for so conspicuous a precedent to be followed by great improvement along this line. *There* was a successful example to be studied, doubly useful because so apparent to all, and already exerting a great and beneficial influence in the harmonizing of architectural and engineering structures with the natural surroundings.

The work of the landscape architect would be of far more value generally, if he were consulted in the beginning, as at the Chicago

Fair, and given an opportunity to suggest changes in the location of buildings, instead of, as in many cases, called in as a kind of afterthought and compelled to make the most of an unfortunate position.

By securing his assistance at the outset, the building would get the immediate benefit of such local features as the site afforded; the trees and rocks would be saved, to serve as a basis for the more extended treatment decided upon, instead of being sacrificed to the profit or convenience of the contractor; the materials removed in the construction of the work could be at once disposed in accordance with the general scheme for the treatment of the grounds, and the building and its setting grow simultaneously toward orderly completion.

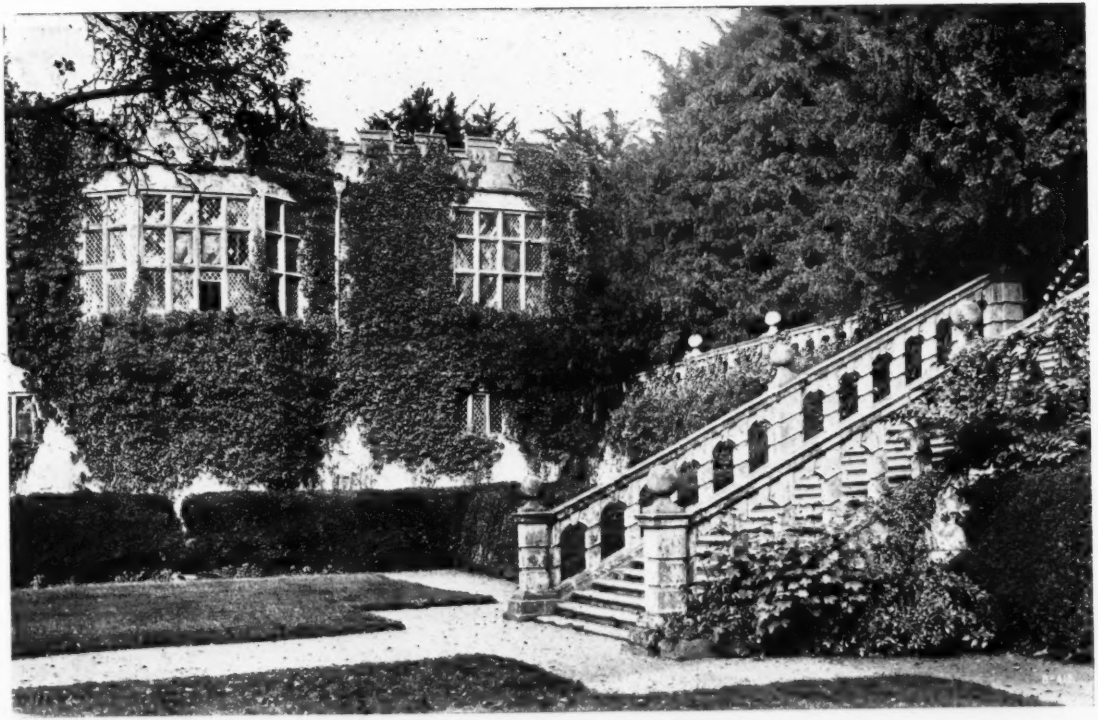
Private dwellings are, perhaps, at present more frequently designed to meet the local requirements than other structures. We occasionally see a modern country home shaded and embowered the first year it is finished; but, further than this, the intelligent study of the conditions at the start by the landscape architect would assist in placing the building in the most effective relations to its surroundings.

He would not only consider, in connection with a dwelling, how it might produce the best appearance from the principal view points, but would give equal attention to the outlook from the house itself. His aim would be to secure the best vistas from the principal living rooms or the verandas most likely to be in use in pleasant weather. He would study the site, and the opportunities it afforded for display or concealment of different portions, in relation to the life of the house, as well as to the harmony of grounds and architecture.

The architect should be willing to meet the landscape architect in the consideration of various points where the work of one merges into that of the other. Each is dependent on the other for the full completion of the picture he has in mind, and both are injured if this ideal, through lack of coöperation, is not reached.

In many cases it would be a great relief for the architect to be free from the responsibility of having to decide on the exact location of a building at a time when his thoughts are filled with the details of contracts and working drawings; and here he can be greatly helped by turning over this part of the work to a landscape architect, or, at least, by leaning heavily upon his advice and suggestion, which are most important and valuable before the final plans are adopted; for the controlling lines employed by the architect should in a measure be governed by the environment.

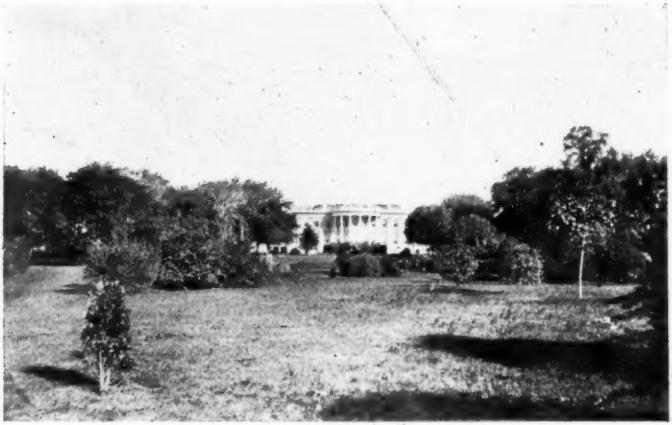
Where the situation is on uneven ground, the design may be relieved by a broken sky-line and entrances on the different sides at varying levels. Where the site is comparatively level, the structure



AN ENGLISH EXAMPLE.

LANDSCAPE WORK AT LENOX, MASS.

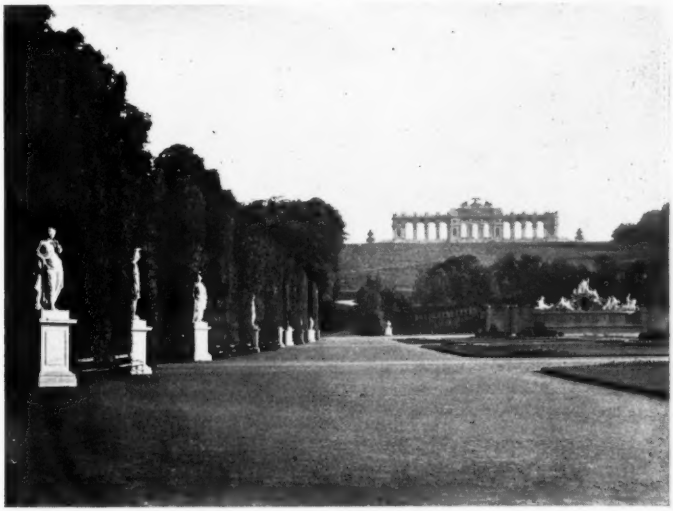
gains by the subordination of all minor features to the main motive, and the concentration of thought on that. In a perfectly level country the desire for a break in the oppressive flatness of their surroundings moves men to build high, monumental outlooks, and employ their talents in endeavoring to supply that which nature has denied them, but supplied in boundless profusion to their neighbors. So, in the work of adding to the effectiveness of buildings and making their surroundings more interesting, success is often attained by the bold



THE WHITE HOUSE AND GROUNDS, WASHINGTON, D. C.

adoption of a formal treatment, where the most can be made of lines of stately trees, well-trimmed hedges, and straight, flower-bordered walks, leading to an elaborate gate or arch. This treatment becomes especially happy when judiciously incorporated in the design for a public park, and gives an opportunity for the architect and sculptor to add to the natural beauty.

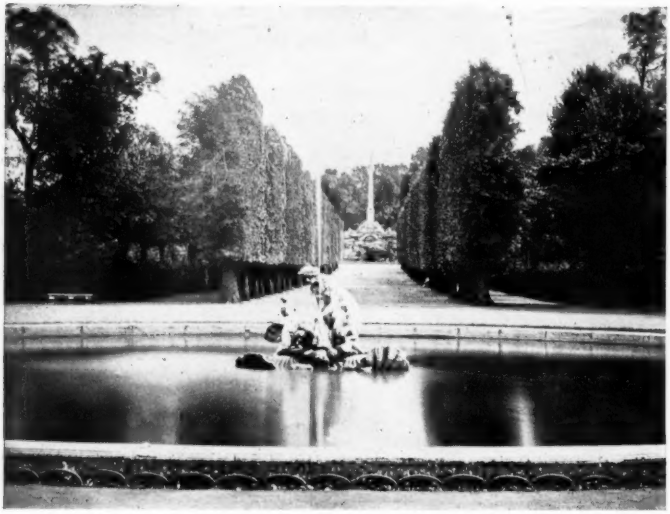
The beautiful examples so placed gain greatly in the total elimination of all surroundings that would otherwise possibly dwarf their height or interfere with light, delicate features which are brought out in strong relief by a background of foliage or a delicately-verdured



PARTERRE, SCHÖNBRUNN PALACE GROUNDS, VIENNA.

hill slope. The thoughts of the passing wanderer are led to dwell on the life work of the subject of the sculptor's chisel, and incline him to linger and admire when the surroundings suggest rest and contemplation.

The public parks of our large cities have been generally laid out and taken care of by men of intelligence and thought, and the results are most creditable. The dweller in large cities can walk along shady paths, under rustic bridges, by cool lakes, without leaving the city limits; he can ride and drive on splendid roads, enjoy the great variety of flowers and foliage growing there, and feel the harmonious blending of natural and architectural features. Just here is where the



THE "OBELISK-ALLEE," SCHÖNBRUNN PALACE, VIENNA.

architect can help in linking land and water together in the general design. The shelter can be placed among the trees along the path, and be of an informal design that will not clash with the park idea; it can be of cool tints with little elaborate ornamentation.

THE BOW BRIDGE, CENTRAL PARK, N. Y.

SHELTER HOUSE, GOAT ISLAND, NIAGARA FALLS.

A GLIMPSE OF CENTRAL PARK, NEW YORK.

THE BETHESDA FOUNTAIN, CENTRAL PARK, NEW YORK.

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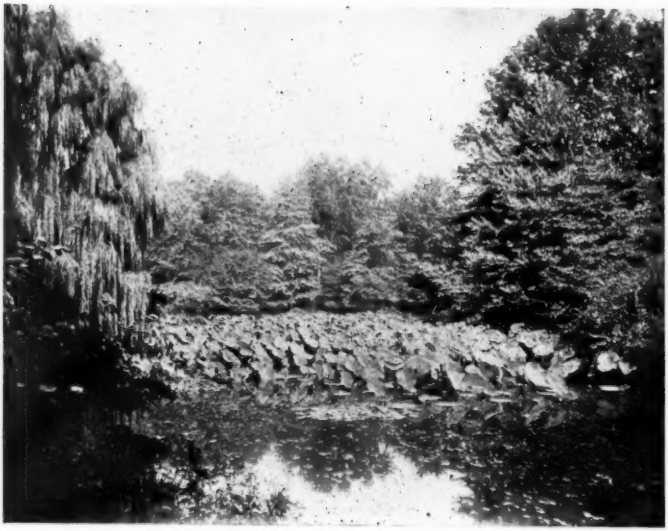
The outlook or tower on the highest ground can have a slender tapering sky line that will even accent the limits, instead of dwarfing the extent of the park grounds. Not only should the bridge be a picturesque structure itself, but the abutments should be made to fit the ground, and not end in mere masonry necessities.

The addition of some of the bright flowering aquatic plants to the pool or fountain combines the daily variations of living examples of the most beautiful and exquisite flowers with the cool, clear effect of running water.

Where music is heard across the water, a blending softness is given to the notes that is distinctly caused by the undulating surface, and

THE BELVIDERE, CENTRAL PARK, NEW YORK.

BRIDGE AND LANDSCAPE, GOAT ISLAND, NIAGARA FALLS.



LILY POND IN CENTRAL PARK, NEW YORK.

IN THE PUBLIC GARDENS, BOSTON, MASS.

THE LAKE AND TERRACE, CENTRAL PARK, NEW YORK.

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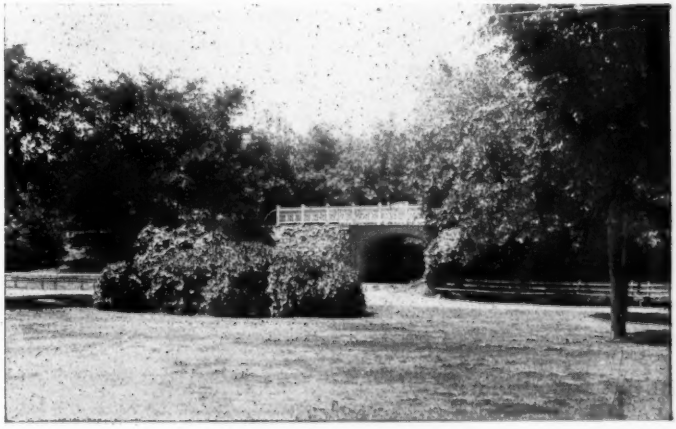
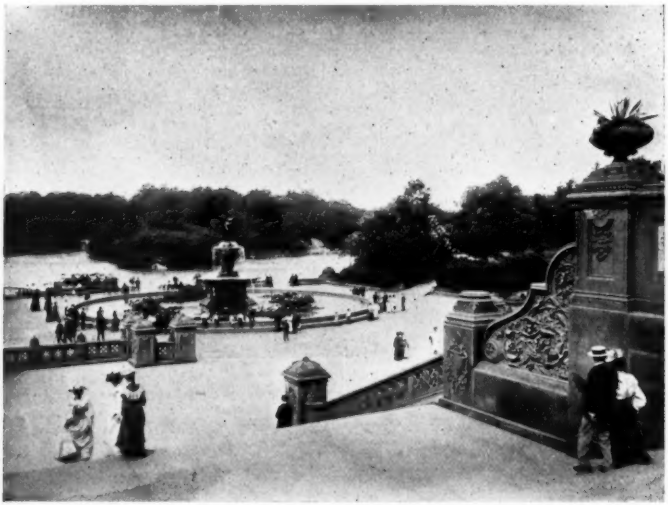
this can be taken advantage of by placing the music stand on an island. Aquatic birds add life to the water, and are seen to advantage from boats, which are more used as their benefits are appreciated.



IN LINCOLN PARK, CHICAGO.



THE TERRACE AND FOUNTAIN, CENTRAL PARK, NEW YORK.

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THE COLONNADE, VERSAILLES PARK, FRANCE.

Where civilization reaches its highest development, we find that the beauty of nature is appreciated as well as the greatest works of man. The Romans had their gardens, and from the earliest times the

wealthy have striven to secure parks and gardens, but the idea of beautiful breathing-spaces for the poor is comparatively modern.

In older countries, there is naturally a survival of the product of the older ideas, and the private parks of Europe represent a development which is, perhaps, hardly paralleled on this side of the water, and furnish the most striking examples extant of the blending of landscape work with architectural ornament. In Italy the formal treatment has been the favorite one,—a geometrical arrangement of

A FLORENTINE DOORWAY AND GARDEN.

IN THE GARDENS, WORCESTER COLLEGE, OXFORD, ENGLAND.

THE SULLY PAVILLION, PALACE OF FONTAINEBLEAU.

walks, adorned with marble steps, balustrades, vases, statues, seats, and arbors. In France the ingenuity of the designer is given great latitude in constructing grottoes, elaborate labyrinths of paths, and an endless variety of fountains. In Spain the beauty of the work of this kind is closely associated with the former grandeur of the builders, and often heightened by the present half-ruined condition of so many of their masterpieces.

In England, where more has been done by individuals in this direction than in any other country, the beauty of the parks and gardens is recognized the world over. The English have developed the lawn, the planted background, the surrounding sky line; they have built their castles often on the rocky shore of a lake or in a forest of noble oaks, have opened up views in various directions, and have generally adopted a broad, generous treatment in the surroundings. They have had many writers on these subjects, and several of the best works are by English authors.

Germany, famed for its castles on the Rhine, has many beautiful structures where the environment is preserved in harmony with the work itself, though in other cases their noblest examples are marred by the close contact of houses of inferior design,—notably the Cologne cathedral.

It is only in recent years that the need of preserving the surroundings of our beautiful buildings has been recognized; this has led many institutions to move their quarters from the closely-built-up portions of the cities to the more open suburbs.

The colleges especially gain by this change, not only in the greater extent and beauty of their grounds, but in the added quiet and repose of the surroundings.

The University of New York has recently moved north of the Harlem river; Columbia College is now building on larger grounds; the Chicago University has an extensive site on the lake front.

The summer hotels have found it necessary to buy extensive tracts of land in their neighborhood to secure the quiet and freedom their guests demand.

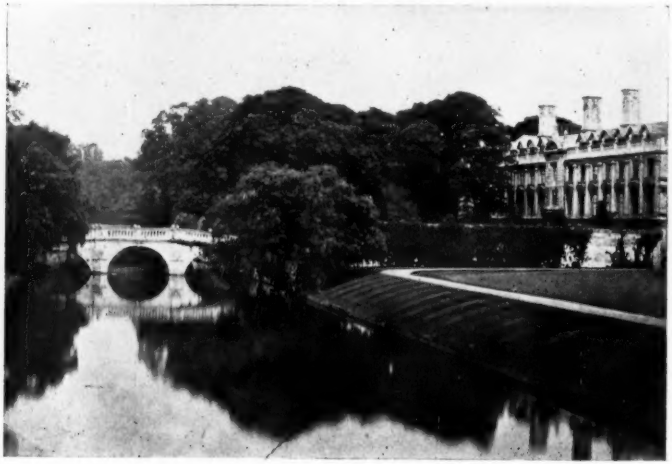
Land improvement companies are developing their property in a more sensible manner by devoting some part of their ground to trees and shrubbery.

The railroads are following the same idea, and it is not rare to find the station in a park or with well-kept grounds about it.

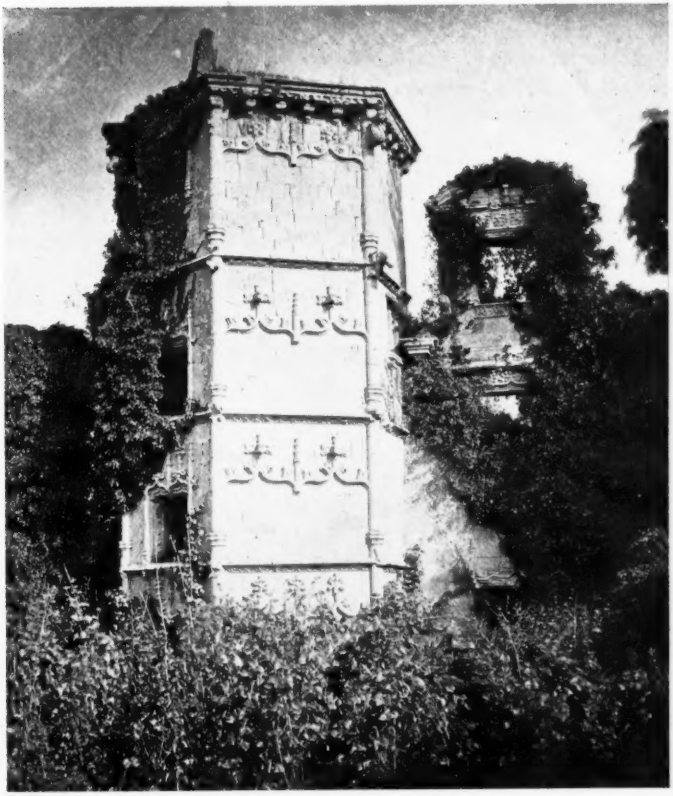
Some of the principles that a few years ago had to be fought for are now taken as a matter of course,—for example, the gain in the extent of grounds by the omission of private division fences and the elimination of iron boundary fences in our city parks.

Comparatively few people know that the work of the landscape architect is carried out in a thoroughly business-like way, and on the same general lines as architectural and engineering designs.

A topographical survey of the ground is first made, and from that a plan is drawn, showing the location of the proposed drives and



CLARE COLLEGE, CAMBRIDGE, ENGLAND.



THE ARTIST TOUCH OF TIME.

walks, with the buildings. The changes in the surface are shown by figures. Next a planting map is prepared, indicating the position of all trees and shrubs to be planted, and giving a list of their names. The detail drawings for special features, such as arbors, summer houses, etc., follow.

Grass-covered areas of ground are the foundation of the simplest as well as the most elaborate designs in landscape treatment. A well-kept lawn is a satisfaction in itself, pleasant to walk on, agreeable to the eye, and alive in its varying tints and growth.

A combination of harmonious colors and informal design admits of endless variety in detail; by arranging the smaller growing plants in

front and the taller ones in the center the mass is made more effective. Plants with colored leaves are now extensively used in this way, as the pleasing effect is more permanent. Flowering plants that have to be renewed every year require more attention than shrubs, and do not have the same lasting qualities.

Shrubbery may be made useful in screening objects that are uninteresting, and beautiful in its variety of color and form.

Great advance has been made in the cultivations of shrubs for ornamental planting; the number of hardy varieties is steadily increasing, and the interest taken in them is growing. Large masses of the same variety are now used to heighten the effect at certain points; the choice specimen is given prominence, more room is allowed for free growth, the pruning is done with more care, and the whole effect is one of great richness in materials and growth.

Plantations of shrubs are used to bring buildings into closer relation to the surroundings; they help to connect the lawn with the larger growing trees and rocks; on the margin of pool, lake, or stream they are especially beautiful, as the effect is often doubled by the reflection in the water.

Ivy and the American ampelopis give a most beautiful effect by carrying the green of the foundation of grass up through the more or less rugged foundation of rough stone to the chiseled base.

Trees, both for shade and to add beauty to the landscape, are of the greatest importance. They represent years of growth, and live even in our city streets; they are the crown on the hill, the companion of road, walk, and building, and the clothing of the hillside and hollow. They are of great variety, the pines and hemlocks, with their deep green needles, affording a noble contrast to the light green leaves of the birch and poplar.

The willows by the spring or brook tell of the cool water to all; the maples, with their scarlet buds in spring and yellow and red leaves in autumn, lend a brightness and vividness to the landscape, and are among the most useful of the shade trees.

Brooks, waterfalls, ponds, lakes, rivers, and the shore of the sea, appeal to man in their different ways of adding beauty to the scene he looks at; and, when nature has failed in supplying the first four of these, he can often add the lacking elements.

Let us hope that the demand for parks, gardens, and the preservation of natural features of beauty will grow, and that the supplying of these wants will be entrusted to men especially interested in the throughly artistic development of all the various opportunities in a business-like and sensible way; thus the best results will be obtained from the expenditure, and stupid mistakes will be avoided.

MODERN MACHINE-SHOP ECONOMICS.

By Horace L. Arnold.

VI. FIRST PRINCIPLES IN THE MANAGEMENT OF MEN.

FROM the earliest days of history to the present moment some men have been employers, and other men have been wage-earners; a few have directed the labor of the many, and gathered and accumulated the surplus goods arising from labor, seldom to the entire satisfaction of either party to the transaction of hiring and serving, more seldom to that of both, and not infrequently to the dissatisfaction of both master and man to the bitter extremity of death.

At this moment the labor trouble at the Brown Hoisting and Conveying Works in Cleveland, having already cost several lives and a large amount of money, is being held in check by military force; something like twelve thousand of the united garment workers go on their annual strike; and the largest remaining body of the Knights of Labor, the Pittsburg glassworkers, has just formally withdrawn from that organization, which, had it from the first been under wise and far-seeing direction, perhaps would have become the controlling factor in American politics.

It is absolutely certain that the best policy of neither labor or capital is universally understood; else the history of to-day could not be written as it is. It is not for the mere whim of idle caprice that men change in one instant from sober, industrious, self-denying, and self-respecting workers into a raging mob, reckless alike of their own lives and the lives of others. It is not without motive that artificers, even of the low type of the Jewish tailors inhabiting the east side of New York, voluntarily assume a condition of temporary beggary, abandon their only source of gain,—the sale of their labor,—and enter upon a struggle against their employers and starvation leagued together against them.

Yet there are masters and men, large employers with hundreds of wage-earners, small employers with only tens or scores of workmen, who have never had the slightest unpleasantness in their mutual efforts, which result in at least such benefits to all concerned as make both parties to their unformulated contract of such value to each other that neither wishes to hazard the chances of change.

Since master and man can in these occasional cases sustain their working relations with mutual peace and prosperity, why can not their fortunate condition become the rule instead of the rare exception?

It is most pitiful that a man should expend his whole life in honest, uncomplaining toil for no gain, for no certainty of so much as food to satisfy his hunger, much less of any future state of ease and comfort in accordance with even the humblest desires.

Labor is the only source of wealth. Wealth is merely accumulated labor, has all the rights and producing-powers of labor, and is, perhaps, better defined as "concrete labor" or "permanent labor" than by any other combination of two words.

There is but one single difference between labor and capital considered as commodities: labor must be sold day by day, while capital can wait for a purchaser. If capital is idle, it does not earn, but the capital itself remains, and can wait. The capital of a wage-earner is his power of working, and he must sell his work from instant to instant; otherwise, it is irretrievably and forever lost to himself and to mankind at large.

Accepting these assertions, which are obviously incontrovertible, it is seen at once that the wage-earner at, say, twenty-one years of age, having, say, the trade of a machinist, owner of himself, with a potentiality of earnings beyond the expenditures required to keep him alive and in working condition, has a certain cash value. One man may die at any moment; not so with the body of day-workers at large; each has a certain expectation of life, and consequently an ascertainable present cash value attaches to each individual. So much is certain.

Shall the machinist be regarded solely in this commercial aspect, as a part of the machine-shop equipment, having certain earning potentialities, giving the reasonable expectation of profits to his employer, a means to an end, in a word simply a tool, to be hired at the lowest possible rate, and discarded promptly upon evidence of reduced efficiency?

Probably the truest kindness and charity and philanthropy will answer this question in the affirmative, with only circumstantial qualifications, which do not in the slightest degree modify the policy.

While the workman is, commercially, a tool, he is also a living animal, and must have a suitable vital environment to make his greatest earning.

This living tool has also the power of thought, which leads to content or discontent from either real or fancied causes and again the greatest earning of this living, thinking tool can be made only when his mind is at ease.

The mental ease of the workman may be secured in two entirely different ways.

He may enter a service where the expectation of his earnings is

made the basis of a time-continuance element of his pay; he may be insured against want or sudden disaster by accident or sickness from the day he goes to work; he may have his life insured by his employment, so that he is certain of a provision for his family in case of his own death; he may be made certain of continued pay in case of disability through sickness or accident, this payment becoming greater with each added year of service; and finally he may have the certainty of retirement on full pay, at an age which still leaves the expectation of some years of enjoyable idleness at the end of his honorable period of respected and self-respecting toil. This is no dream. It is the policy at Dolgeville, not of a machine shop, but of a manufacturing establishment, in no way differing in its labor employment from a machine shop.

Or the workman may enter service where he is made to feel that he is watched over and cared for individually; that the management is his individual friend; that he is to be pushed to his utmost earning capacity and paid in accordance to his production; that discharge can come only from an intentional fault of his own; and that in sickness, suffering, and death he and his will be assisted and comforted—to what extent? That is a question which cannot be answered in exact terms under the paternal policy of dealing with workmen which obtains in the Baldwin Locomotive works, where there has never been a strike, and where men drive themselves to their utmost production.

Of the two methods that which deals with the worker as a simple tool, a mere commmercial commodity, is undoubtedly in every way the better. The conditions and the rewards are fixed, certain, just, and satisfactory, and they are founded, not on fear or favor, but on a correct basis of money values by which the capital of the master joins with the capital of the workmen in the form of their own bodies, to produce an earned increment of wealth, which is continually divided among all, in sufficient accordance with the needs of each.

If any machine-shop owner wishes to reach this ideal condition of absolutely harmonious effort, he must himself, by his own business foresight, inaugurate such a policy as will result in the Dolgeville or Baldwin or Midvale unity of effort.

The typical wage-earner is, first of all, incapable of managing any business, even his own,—much more that of an assemblage of his fellows. Many large employers have, indeed, come out of the workshop, but they came out early in life; they were never "union" or "trade-society" men; they never affiliated with the herd of wage-earners. Cradled in poverty, they yet had business instincts from the first, which no life-long wage-worker ever has.

It is this lack of business and money-handling and managing ca-

pacity which makes all "labor movements" certain failures from the moment of their inception to the infallible disaster of their certain dissolution.

If a man is capable of managing, servitude is revolting to him, and he will not continue a day-wage earner.

But every and any business manager who employs wage-earners can, if he chooses, places his labor on such a commercial footing that no man can leave his service or question his wishes without a prospect of pecuniary loss which the day-worker is not willing to face.

The employer desires the greatest output for the least wages; the workman desires the greatest day-pay obtainable; the employer does not care whether the day wage rate is lower or higher,—he simply desires the largest obtainable profit at the end of each individual transaction. To satisfy the man there must be an increase of wages; to satisfy the master there must be an increase of profit; hence, to satisfy both master and man, there must be an increase of output per hour of labor, because nothing else can give the workman higher day-pay and at the same time increase the profits of the employer.

The fixed charges, interest and depreciation of plant, office expenses, advertising, trade-soliciting, and insurance vary but slightly as the volume of business varies. Output and profits may double in volume with a very small or no increase of fixed charges.

It is in the labor-cost that the manager must find the variable which alone can favorably affect his balance-sheet.

The superintendent, himself a product of the workshop, and knowing perfectly well what the worker can do, stops before a machine-tool which is not removing more than one half the metal per minute which might well and easily be removed; he says nothing, and the workman says nothing, yet each is perfectly aware of what passes in the mind of the other. Continuing his inspection, the superintendent pauses before a vise or floor-hand, with the same silent observation and result. If the superintendent speaks to the workman, he makes a mere casual remark, which the workman returns with deferential good feeling.

It is "a fair day's work for a fair day's pay, and nothing to say."

Yet the cost of the work must be lessened, or the work must stop; either there is no profit, or competition forces a lower selling price. The workman will not exert himself; his output is up to the average of that shop; he is punctual, sober, orderly, civil, and a good craftsman, and is secure in his place because he and his fellows stand shoulder to shoulder, doing so much and no more. If the superintendent demands a greater output, the man seems to exert himself to meet the requirement, but the result is the same in work finished, and the seed

of shop trouble is sown. But the superintendent does not commit the folly of demanding more output without increased pay. He offers the workman a piece-rate which will require a slightly increased production to bring the workman his day-rate of pay. The workman slightly exceeds the difference, and adds a dollar or two to his week's wages. The superintendent encourages him, and the next week he does better still, draws still more money, and again has good words given him. The workman now begins to really exert himself; he takes heavier cuts, he thinks, he devises new expedients, new methods, and, if still encouraged, will, in a month or two, be drawing perhaps double his previous pay, and yet leave the shop gainer as well as himself. Other hands become aware of the fatness of this piece-worker's pay-envelope, and respectfully solicit the change to piece-work in their own behalf; the system of piece-prices becomes general in the shop, with the result of more and better output at a lessened piece-cost and a greatly increased wage-rate to the men. Then the management says to the superintendent: "You have only average men, yet you are paying about double average wages; you must change this." A general cut is made in the piece-prices, and the men may again increase their pay, and again have the rates cut, or they may be wise, foresee the certain conclusion of the matter, and stop at a very slight increase of production, which will give them at piece-prices a day-pay rate only a small safe margin above the open market-rate of their labor.

This is the inevitable and unvarying result of a fixed piece-rate, precisely the same as a fixed day-wage leads to the "fair day's work for a fair day's pay"; and this is generally regarded by both masters and men as the inevitable finality of the piece-price system, and is the ultimate result if the workmen are considered, not as individuals, but as a class.

The superintendent is perfectly aware that some of his men could largely increase their daily out-put, and he introduces the variable piece-rate; if the production reaches, say, 10 pieces per day, the piece price is to be, say, 35c; if below 10 pieces per day, the price paid is only 25c per piece. This has the effect of stimulating the workman to produce 10 or more pieces per day, if it is possible for him to do so, provided he feels sure that the piece-rate is not to be cut.

In case the piece-price is based on a high efficiency of the best tools obtainable, this individualizing of the workmen by the expedient of an unchanging "differential" piece-price is a perfectly safe operation commercially, as it secures the lowest possible piece-cost of output, and at the same time permits the workman to earn more than the prevailing rates of day-pay in the open market. The employer, there-

fore, is able to compete with any selling rates which can be offered by others, and the workman is obtaining more for his labor than he could obtain elsewhere, and feels that he is his own master, the arrangement resulting in that harmony of effort of master and man which alone can lead to permanence of best obtainable results.

Nothing can be permanent which does not in itself contain the elements of commercial stability. Whatever does not pay its own way must sooner or later cease to exist.

Harmony between master and man must include business success, and permanent business success can be certainly relied upon only when the lowest piece-price production is joined with the highest day-pay rate which the workman can obtain anywhere.

The day-rate of the laborer is less than the day-rate of the trained machinist, yet the specialized laborer's production on a single class of work may, and often does, fully equal, in both quality and quantity, that of the most skilful mechanic. A consideration of this fact opens up a line of inquiry ending in a question as to the need of using machinists to build machines.

Machine shops have been and are operated on the theory that their object is to build machines. In this art view of the case the use of machinists, thoroughly trained and capable of a far wider range of effort than the narrow round of shop routine demands, should constitute the principal part at least of machine-shop labor equipment. But the ultimate object of operating a machine shop is, not to make machines, but to sell machines for more money than they cost. In this commercial view of the case it appears that the ultimate object of the machine-shop is not to make machines, but to make money, and it becomes evident that the trained mechanic need not of necessity have any part in the management of the shop, and it becomes pertinent to enquire whether it is best to have a mechanic anywhere near the management. The commercial instinct and the mechanical instinct are very rarely united in the same individual, and the largest and most successful machine-making establishments in this country to-day are controlled by non-mechanical managers who succeed because they are judges of what will sell, and can foresee the probabilities of future demand.

Viewing men as tools, every added unused power or ability is a detriment.

Ingeniously complicated tools have been devised and built which combined the powers of the lathe and planer, the slotter and driller, or the planer and milling machine, but they are of use only to the smallest jobbing-shop and the amateur; the superintendent of a large establishment would not consider them for an instant as possibly valuable ad-

ditions to his plant. Why, then, need the living tools be of diversified powers, when only a single function is to be exercised? It is a common saying that there are no more general machinists created; it is a certainty that a very large part of the machine work of to-day is done and well done by specialized laborers, and in the lighter branches even by women working side by side with men at machines which only a short time since were handled by men exclusively.

It seems, then, that the place of the machinist in the machine shop is not very near the top in rank; nor need anything like a majority of machine builders be trained, all-around mechanics. There must be some machinists; there must be some tool-makers; but there may well be a vast majority of one-operation workers, able to manage a single tool and force its production to the highest limit, but otherwise innocent of technical knowledge or skill.

Such single-effort workers are undoubtedly destined to do by far the greater part of the machine building of the future. The place of women in the machine shop cannot now be foretold. Year by year they take heavier work and fill more varied positions, as in electrical construction and bicycle-part making. All ordinary machine work is perfectly within a woman's physical powers; but it seems now, in view of the results of two generations of women metal workers in some New England districts, wholly undesirable that women should become machinists. Still, as we are not ready to adopt the Chinese plan of drowning girl-babies, and workingmen of the machinist grade show a continually diminishing willingness to marry, perhaps the superfluous woman can do worse than enter the machine shop. Where she has entered the shop, she has made the shop better in appearance, though at what sacrifice to herself can not yet be said.

In completing these unfilled outlines of what I believe to be the true economics of the most important present engine of human advance toward better living, the machine shop, I feel that I should use my final words in urging a serious consideration of the methods of dealing with labor adopted by the Baldwin Locomotive works and the Midvale Steel works, or, better still, the absolute despotism of Dolgeville.

I speak from experience on the workman's side of the matter. Day labor is slavery, pure and simple; endurable only because it is voluntary, permitting the slave to select his master. Work for wages merely is vile, and vilely degrades the worker. Every strike—senseless folly as the strike has always proved—is a revolt of manhood against the degradation of unquestioning abandonment of self to another's rule.

At the outset of my twelve years of life as a journeyman machinist

I learned the immortality of time by finding that, in trying to "kill the day," I unendurably increased its seeming length to myself, while, by trying to "kill the work," the day passed so swiftly that six o'clock came as a regretful surprise, too quickly because it left my self-alloted task incomplete. I drew the highest pay; I had the friendship of my employers; every day was full of interesting lessons to me; and I think now, looking back thirty years, that the easiest money I ever earned was earned at day wages in the machine shop. But I saw my shop-mates, lacking my perpetual delight in mechanical operations, some sullen, defiant, jealous, desperate under the double-thonged lash of restraint and their own necessities; others careless alike of themselves and life, wearing the slow hours of daylight away without a thought or an ambition beyond the drinking places in which they passed so much of their nights as their need of sleep permitted; always in debt and always, when perfectly sober, wholly at war with themselves and their own lives.

To-day there is in free, happy America the dogged endurance of the bayonet at Cleveland, the sullen ending in failure of the costly Knights of Labor experiment of the glassworkers at Pittsburg, and the noisy jargon of the Hebrew garment workers as they talk themselves into the frenzy needed to sustain them through the weeks of starving in which they must fight, as best they know how, their ignorant battle against the reducing of their wages.

Let machine-shop owners read Taylor's exposition of the Midvale differential piece-rate system; let them examine the workings of the same system with the "human interest" addition at the Baldwin Locomotive works; and let them be made familiar with the benevolent despotism of Dolgeville.

Let them regard the workman as what he is,—a tool,—and regulate his price by his out-put; let them add to this, if they like, the silvern speech of words fitly spoken, as at the Baldwin shops, or, best of all, to my thinking, let them adopt the golden silence of the ledger and the cash-box, as at Dolgeville, and so make an end to that war of self on self, the "conflict of capital and labor," which is now the bitter disgrace of civilization in its highest form.

Underlying the whole vast fabric of trade and commerce is the machine shop, sustaining all, and making all possible.

Let the easy and profitable methods by which labor is made contented and enjoyable at the Midvale, Baldwin, or Dolge establishments become common in the machine shops of America, and those methods will spread the world over, carrying with them the true liberty which is to be found only in the power of the wage-earner to secure happiness by his own efforts.

THE MANUFACTURE AND USE OF BRICK FOR STREET-PAVING.

By H. K. Landis.

IT is difficult to determine the exact time when brick was first used for street-paving. In a limited way it was undoubtedly employed in ancient times, but it was not much more than a century ago when the Dutch began the development of a brick-paving industry which now has attained considerable magnitude, especially along the River Yssel. The Japanese employed this material about the same time, and the English more than half a century later. In the United States, however, we find no brick-paved streets before 1870, at which date a small section of street was paved at Charleston, W. Va., the pavement being relaid in 1873. Though this brick is simply a hard-burned common variety laid on a board foundation, after twenty-three years in use it shows but one-fourth inch average wear. The example set by Charleston was followed in 1875 by Bloomington, Ill.; in 1880, by St. Louis; and in 1885, by several Ohio towns.

The real beginning of the industry was in 1885, since which it has so increased that brick paving is now used in over three hundred cities of the United States. The older bricks were made from glacial and other silicious clays, including fire clay, none of which will now satisfy the rigorous requirements of construction engineers, although brick is even now made from fire-clays in West Virginia and Tennessee; the high temperature and frequent checking or cracking in the latter, however, are serious drawbacks in manufacture. The principal material used in the manufacture of vitrified brick is a rather soft shale containing about 56 per cent. of silica and 13 per cent. of fluxing constituents.

Making the Brick. This shale occurs near the surface, and is mined by stripping the soil from above the deposit and excavating, either by hand-labor aided by blasting, or by means of a steam shovel. The latter method is the more economical when the capacity of the works is sufficient to keep the shovel busy the entire time. The fire-clays are procured from beneath the surface by the usual pillar and room system of mining used with coal, the pillars being taken out subsequently.

Grinding. After the shale has been placed in cars and carried to the works, it is ground in a chaser, two chasers being required for

each brick machine. The chaser consists of a stationary pan about nine feet in diameter, having two discs with a twelve-inch face and weighing nearly three tons each, which chase each other round the annular bottom of the pan, crushing the shale beneath them, which passes through slits in the bottom, when sufficiently fine.

Screening. The ground material from the pans is not uniform in fineness, and must be sifted. Therefore it is run over shaking screens or through revolving cylindrical screens. Fineness is an important element, as the finer clay produces the stronger brick; moreover, screening increases the capacity of the chasers.

Tempering. This should be thorough, in order to make a homogeneous mixture without any air spaces. Fire-brick manufacturers accomplish this mixing in a chaser or Chilian mill, but, as that is rather slow, the paving-brick makers use a pugmill about nine feet long, having inclined knives set into a central shaft which mixes the material and pushes it to the other end of the cylinder.

Molding. Brick machines are of two types,—"end cut" and "side cut." In both the material is forced through a die, which, in the former, is the shape of the smaller cross-section of a brick; in the latter, the size of a longitudinal section of a brick stood on edge. This process produces bars of clay, which are taken by a continuous belt to a wire cutting-off attachment, where they are cut to the proper length or the desired thickness. The clay from the pug-mill is forced through these dies by screw knives set in a horizontal shaft, or by means of intermittent plungers, the former being the better.

Repressing. Though the rough surface and sharp edges left by the cutting wire on the brick have been accepted by consumers, there is now a growing demand for a nicely-finished article with rounded edges. This has made pressing in properly-shaped dies necessary, producing at the same time a brick which is slightly more dense and somewhat less liable to be laminated.

Drying. After being molded or repressed, the brick are dried in tunnel-driers, into which they are run while stacked in a checker-work on cars. Too rapid drying may cause cracks, while slow drying decreases the output; between the two extremes there is a happy mean, the exact location of which is often too carelessly determined.

Burning. The best brick are made in kilns where the heated air is drawn downward through the brick by a stack outside, thus insuring an even distribution of heat, regulated by the firing and the damper. These down-draft kilns are of two types; in the east the round beehive kiln is used, while along the Mississippi the square kiln of three times the capacity is preferred. Great care must be exercised in the burning, as even then the average percentage of good

pavers obtained is but seventy. Too high a heat will soften and thus dent the brick; they are too soft, if not burned sufficiently; when cooled too quickly, they check or crack, and become brittle, while slow cooling will anneal them, producing a very desirable toughness. When burned, the brick should be a brownish red: a lighter color indicates too much lime in a shale brick, though it is characteristic of fire-clay pavers. In any case they are burned until a partial fluxing takes place.

Properties and tests. For street-paving purposes brick must be high grade, the principal qualifications being toughness in resisting wear and impermeability in preventing the absorption of water, which might freeze in the brick and thus disintegrate it. There are other qualifications, however, that enter into specifications.

Structure. Laminations may occur in a brick, when it is not thoroughly pugged; with end-cut brick these are concentric and paralleled with the larger axis, while with side-cut brick they run in the direction of traffic, making the brick less liable to chip from contact with horses' hoofs. The worst feature, however, is the cracking or peeling-off upon freezing. In general, such brick must not be used.

Density. The specific gravity will average 2.30 in shale brick, though it may vary two-tenths either way. As these brick absorb about one per cent. of their weight of water, density and porosity are practically identical in showing permeability. Hardness is another relative test; it ranges between 6.5 and 7. on the mineralogist's scale of 1 to 10.

Compression. Where the traffic is heavy and the filling between bricks is sand alone, this is an important factor. Tests show an average ultimate strength of about 15,000 pounds per square inch for shale pavers, and 10,000 for fire-clay brick. There is, however, a wide range, due partly to the difficulty in making the test properly, and partly to improperly-selected material.

Breaking. Should the foundation of a pavement be insecure, a brick may have no support under the middle; hence was devised the test called cross-breaking strength, or modulus of rupture, in which the brick is supported on two rounded wedges six inches apart, pressure being applied on the center. The breaking stress is found to be about 25,000 pounds per square inch of section.

Abrasion. The ability of a brick which has been laid in an unyielding foundation to resist wear is well brought out in this test. A strong cylinder is hung on trunnions and filled to one-fifth its capacity with brick, among them the ones to be tested; the dimensions of this rattler are usually two feet in diameter and three feet in length, though these vary somewhat. A report to the National Association of

Fire-Brick Manufacturers by Prof. Edward Orton* upon standard tests shows (1) that the loss in a rattler is nearly uniform where the brick occupy but 10 to 25 per cent. of the volume; (2) that the abrasion is greatest in the first ten minutes, due principally to chipping, the per cent. loss decreasing at each subsequent period, and the usual practice being to continue the test for one hour; (3) that above twelve inches the length of rattler has no influence on the result; (4) that "the loss varies with the number of revolutions much more than with the time of revolution" (the commission have not yet decided on the proper number of revolutions); (5) that from 26 inches in diameter of rattler upward, the loss in abrasion is nearly uniform, but below that, the loss decreases with the diameter. It was found that cast iron in the rattler gave unsatisfactory results, and that standard brick were preferable to fill up with. Bricks usually lose about 10 per cent. of their weight, and granite 4 per cent., in this test. Square-cornered brick show a greater loss than those with edges rounded in manufacture.

Having tested a number of brick with varying results, making it difficult to determine which is the better, the problem is to give each test its proper weight, so that the tests collectively can be compared. Prof. H. A. Wheeler† has devised the following formula for this purpose, in which the rating for an average paving-brick will be 100.

$$V = 5(18 - R) + 2(7 - A) + \frac{T}{220} + \frac{C}{1000} + \frac{10}{3.25 - D} + \frac{10}{7.5 - H}$$

V = an arbitrary comparative rating.
R = rattler loss in percentage of weight of brick.
A = absorption in " " total " " "
C = crushing strength per square inch.
T = modulus of rupture per square inch.
D = specific gravity.
H = hardness by Moh's mineralogist's scale.

The mean of a large number of tests gives as an average for the above:

R = 8.0 per cent.	C = 10,000 pounds.
A = 2.0 " "	D = 2.25.
T = 2,200 pounds.	H = 6.5.

which, substituted in the formula given, will make V = 100. Very good bricks should range above this. From this it will be seen that the rattler test is given an importance equal to all the others combined, which is as it should be.

* *Clay*, January, 1896.
† "Vitrified Paving Brick," T. A. Randall & Co., Publishers, Indianapolis.

Size of brick. This is a point on which engineers disagree, although most of the manufacturers agree on the standard building-brick size, $8\frac{1}{2} \times 2\frac{1}{2} \times 4$ inches; for then underburned or rejected brick can be sold for building purposes, thus preventing loss and permitting a lower price on No. 1 pavers. A block $4 \times 3 \times 9$ can not be burned as successfully as a smaller brick, and will not vitrify so thoroughly, though some claim that it is cheaper to lay. A number of patents have been issued on grooves and other devices in the sides of brick, designed to hold the cement and asphalt filling between bricks, so as to prevent loosening. Such devices are of doubtful utility, and, like salt glazing, may cover a multitude of evils under a single advantage.

Construction of street pavements. If a macadam road is to be replaced by brick paving, the macadamizing is first removed, screened, and sifted, as some of the stone can be used in the concrete or in back filling, and the road is then excavated to very near the depth required by t. e grade stakes. The earth is then surface finished by hand and rolled with a steam roller weighing not less than six tons, until compact. Beginning at this point, practice differs. Some will have two inches of sand to drain off the water, covered by six inches of concrete foundation; some, an eight-inch sand foundation covered by a course of brick laid flat; some, broken stone with or without sand. In any case such foundations are wetted and thoroughly compacted by the steam roller. The best and most popular foundation, however, is concrete four to eight inches thick, mixed dry and thoroughly hand-rammed in place. In some cases, to prevent serious freezing, subdrainage is secured by means of drain tile sunk in the soil under the foundation and beside the curb on either side. This precaution would seem unnecessary, did not experience prove its value. The foundation must be made with particular care; if of concrete, it should not be laid in freezing weather, nor should the brick be laid upon it in cold weather without proper provisions for expansion. The binding which will otherwise result as the pavement expands will cause it to rumble, as if it were hollow, when wagons run over it, or may even force up considerable sections of the brick, such being the annoying experience of several cities. It is important that the underside be well drained to prevent local softening of the soil, and also the freezing of water, which may raise the foundation and result eventually in serious cracks. On the surface of this concrete is placed a cushion of dry lake sand from one to two inches thick, the surface of which should be shaped perfectly true to grade and section, as the brick will lie directly upon it. The vitrified brick are then laid with their length at right angles to the centre line of the street,—except at

street intersections, where the angle is forty-five degrees,—and are kept in perfect line and level with adjacent brick. They are laid so that the bricks on successive courses break joints at least one-third their length, and are then rammed with a 75-pound rammer, or rolled with five-ton roller. The joints between bricks are filled in with sand, a mixture of asphalt, or concrete, the last being preferable. The sand is brushed in, and a thick layer of sand remains on the bricks to fill such voids as may occur. Asphalt, when preferred, is poured at 300° into the joints until they are entirely full, avoiding any excess. As the cement grouting settles into the joints, it is followed by more, and, when the joints are full, sand is sprinkled over them. This is done to prevent the surface from drying out before it is perfectly set. This top dressing is used in all cases, hot sand being sometimes used with pitch or asphalt. The street is then opened to travel.

Inspection. The inspection of brick is best done at the kilns, but inspection on the ground should never be dispensed with, and everything should be done strictly according to specifications. The engineer should have numerous grade stakes and marks on the curbs for the guidance of the contractor, and should have an assistant, who may also be a constant inspector of the work; for, if doubtful matters are left to the discrimination or judgment of contractors or foremen, the advantage is not likely to be on the side of the city. Specifications, preliminary and final agreements, and contracts should be full, explicit, and in duplicate. The specification and bid should include all details, with the disposition of possible extras included in the specification.

Cost of construction. This item depends upon many conditions, principally freight and character of foundation employed. None but the best obtainable brick should be used in any case. Brick can be bought for $9 per 1,000, unrepressed, or $10.50, repressed at the kilns. Ohio and Illinois are the largest producers of paving-brick. Asphalt is landed from the vessels at New York and Philadelphia. Consequently brick paving costs in St. Louis, per 100 square feet, $14.50 to $15.00, and asphalt $26 to $30,—practically twice as much; while in Brooklyn asphalt pavements are cheaper than brick. Thus we see that the difference lies in freight principally.

General considerations. Wooden blocks laid on end are used where noise is the main thing to be avoided,—as on London streets,—and noiselessness is their only merit. In cost they rank with Telford pavements and brick. Granite blocks and asphalt are usually more expensive, while cobble stone and macadam are less so. According to Prof. Wheeler, the cost of repairs in St. Louis per 100 square feet has been 11 cents for granite, 50 cents for wood and for asphalt, 70

cents to $3.37 for macadam, and as much as $9.40 for limestone macadam. The cost of maintenance of paving-brick construction lies between that of granite and asphalt. An estimate by Rudolph Hering of cost of traction on different pavements is here given:

Comparative Traction with a Given Load.

Iron rails	1		horse.
Street asphalt	1⅔		"
Brick	2¼	to 2¾	"
Granite blocks	3⅓	to 5	"
Wood	5	to 6	"
Good macadam	8		"
Cobble stones	7	to 13	"
Ordinary earth	20		"
Sandy earth	40		"

It will be noticed that brick offers comparatively little resistance. Brick are made with rounded edges at present, to afford a footing for horses, making it available for grades up to 10 per cent. It is not known how long brick will last. The brick first laid are not yet worn out, and they are far inferior in quality to those of present manufacture. Some show a wear of an inch and a half after twenty years in service; others, but a half inch. Some of the older pavements are being replaced by reason of insufficient foundation and settling, due to the tearing up of the street for pipe-laying, etc. There is no pavement extant which will withstand the pernicious effects of digging up to get at underground pipes. It would be far better, everything considered, to have all underground pipes and wires laid in a conduit large enough to admit a man in addition than to have otherwise good streets converted into a series of mounds and ditches. Back-filling of excavations should always be done with sand or gravel. Brick are kept clean easily, and, with adequate sewers, may be flushed. There are no crevices to fill with decaying matter, and the low absorption (1 per cent.) keeps out all liquids; so that, outside of asphalt, it is the most sanitary pavement yet devised. Macadam roads must be kept wet in cities to prevent dust, and a little too much water means mud; flushing with water does not affect brick in any way, especially when the joints are filled with asphalt or cement.

Cities which have used brick paving in the past are now improving their streets with the same material, and no better recommendation can be given it than this practical endorsement.

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Colliery Guardian. *w.* 27*s.* 6*d.* London.
Compressed Air. *m.* $1. New York.
Contemporary Review. *m.* $4.50. London.
Domestic Engineering. *m.* $2. Chicago.
Electric Power. *m.* $2. New York.
Electrical Engineer. *w.* 19*s.* 6*d.* London.
Electrical Engineer. *w.* $3. New York
Electrical Engineering. *m.* $1. Chicago.

Electrical Plant. *m.* 6*s.* London.
Electrical Review. *w.* 21*s.* 8*d.* London.
Electrical Review. *w.* $3. New York.
Electrical World. *w.* $3. New York.
Electrician. *w.* 24*s.* London.
Electricity. *w.* $2.50. New York.
Electricity. *w.* 7*s.* 6*d.* London.
Engineer, The. *s-m.* $2.50. New York.
Engineer, The. *w.* 36*s.* London.
Engineer & Contractor. *w.* $1. San Francisco.
Engineers' Gazette. *m.* 8*s* London.
Engineering. *w.* 36*s.* London.
Engineering Assns. of the South. Nashville.
Engineering and Mining Journal. *w.* $5. N. Y.
Engineering Magazine. *m.* $3. New York.
Engineering-Mechanics. *m.* $2. Phila.
Engineering News. *w.* $5. New York.
Engineering Record. *w.* $5. New York.
Engineering Review. *m.* 7*s.* London.
Eng. Soc. of the School of Prac. Sci. Toronto.
Eng. Soc. of Western Penn'a. *m.* $7. Pittsburg.
Fire and Water. *w.* $3. New York.
Forester, The. *bi-m.* 50 cts. May's Landing, N.J
Fortnightly Review. *m.* $4.50. London.
Forum, The. *m.* $3. New York.
Foundry, The. *m.* $1. Detroit.
Garden and Forest. *w.* $4. New York.
Gas Engineers' Mag. *m.* 6*s.* 6*d.* Birmingham.
Gas World, The. *w.* 13*s.* London.
Gunton's Magazine. *m* $2. New York.
Heating and Ventilation. *m.* $1. New York.
Ill. Carpenter and Builder. *w.* 8*s.* 8*d.* London.
Improvement Bulletin. *w.* $5. Minneapolis.
India Rubber World. *m.* $3. New York.
Indian and Eastern Engineer. *w.* 20 Rs. Calcutta.
Indian Engineering. *w.* 18 Rs. Calcutta
Industries and Iron. *w.* £1. London.
Inland Architect. *m.* $5. Chicago.
Inventive Age. *s-m.* $1. Washington
Iron Age, The. *w.* $4.50. New York.
Iron and Coal Trade Review. *w.* 30*s.* 4*d.* London
Iron & Steel Trades' Journal. *w.* 25*s.* London
Iron Trade Review. *w.* $3. Cleveland.
Journal Am. Chemical Soc. *m.* $5. Easton.
Jour. Am. Soc. Naval Engineers. *qr.* $5. Wash.
Journal Assoc. Eng. Society. *m.* $3. St. Louis.
Journal of Electricity, The *m.* $1. San Francisco.
Journal Franklin Institute. *m.* $5. Phila
Journal of Gas Lighting. *w.* London.
Jour. N. E. Waterw. Assoc. *q.* $2. New London.
Journal Political Economy. *q.* $3. Chicago.
Journal Royal Inst. of Brit. Arch. *s-q.* 6*s.* London
Journal of the Society of Arts. *w.* London.
Journal of the Western Society of Engineers. *b-m.* $2. Chicago.
Locomotive Engineering. *m.* $2. New York.
Lord's Magazine. *m.* $1. Boston.
Machinery *m.* $1. New York.
Machinery. *m.* 9*s.* London.
Manufacturer and Builder. *m.* $1.50. New York.
Manufacturer's Record. *w.* $4. Baltimore.
Marine Engineer. *m.* 7*s.* 6*d.* London.
Master Steam Fitter. *m.* $1. Chicago.
McClure's Magazine. *m* $1. New York.
Mechanical World. *w.* 8*s.* 8*d.* London.
Metal Worker. *w.* $2. New York.
Milling. *m.* $2. Chicago.
Mining. *m* $1. Spokane.
Mining and Sci. Press. *w.* $3. San Francisco
Mining Industry and Review. *w.* $2. Denver
Mining Investor, The. *w.* $4. Colorado Springs.
Mining Journal, The. *w.* £1. 8*s.* London.
Municipal Engineering. *m.* $2. Indianapolis
National Builder. *m.* $3. Chicago.
Nature. *w.* $7. London.
New Science Review, The. *qr.* $2. New York.
Nineteenth Century. *m.* $4.50. London
North American Review. *m.* $5. New York
Physical Review, The. *b-m.* $3. New York.
Plumber and Decorator. *m.* 6*s.* 6*d.* London
Popular Science Monthly. *m.* $5. New York
Power. *m.* $1. New York.
Practical Engineer. *w.* 10*s.* London.
Proceedings Engineer's Club. *q.* $2. Phila.
Proceedings of Central Railway Club.
Progressive Age. *s-m.* $3. New York.
Progress of the World, The. *m.* $1. N. Y.
Railroad Car Journal. *m.* $1. New York
Railroad Gazette. *w.* $4.20. New York.
Railway Age. *w.* $4. Chicago.
Railway Master Mechanic *m.* $1. Chicago.
Railway Press, The. *m.* 7*s.* London.
Railway Review. *w.* $4. Chicago.
Railway World. *m.* 5*s.* London.
Review of Reviews. *m.* $2.50. New York.
Safety Valve. *m.* $1. New York.
Sanitarian. *m.* $4. Brooklyn.
Sanitary Plumber. *s-m.* $2. New York.
Sanitary Record. *m.* 10*s.* London.
School of Mines Quarterly. $2. New York.
Science *w.* $5. Lancaster, Pa.
Scientific American *w.* $3. New York
Scientific Am. Supplement. *w.* $5. New York
Scientific Machinist. *s-m.* $1.50. Cleveland, O.
Scientific Quarterly *q.* $2. Golden, Col
Scribner's Magazine. *m.* $3. New York.
Seaboard. *w.* $2. New York.
Sibley Journal of Eng. *m.* $2. Ithaca, N. Y.
Southern Architect. *m.* $2. Atlanta.
Stationary Engineer. *m.* $1. Chicago.
Steamship. *m* Leith, Scotland.
Stevens' Indicator. *qr.* $1.50. Hoboken.
Stone. *m.* $2. Chicago
Street Railway Journal. *m.* $4. New York.
Street Railway Review. *m.* $2. Chicago.
Technograph. *yr* 50 cts. Urbana, Ill.
Technology Quarterly $3. Boston.
Tradesman. *s-m* $2. Chattanooga, Tenn
Trans. Assn Civil Engs. of Cornell Univ. Ithaca.
Trans. Am. Ins. Electrical Eng. *m.* $5. N Y.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* $10. New York.
Transport. *w.* £1. 5*s.* London.
Western Electrician *w.* $3. Chicago.
Western Mining World. *w.* $3. Butte, Mon.
Western Railway Club. Pro. Chicago.
Yale Scientific Monthly, The. *m.* $2.50 New Haven.

ARCHITECTURE & BUILDING

Design, Construction, Materials, Heating, Ventilation, Plumbing, Gas Fitting, Etc.

Houses Built for Show.

ABOUT suburban homes clustered around American cities, Mr. R. Clipston Sturgis, in *The Cosmopolitan* for June, expresses the opinion that they lack individuality and seclusion, and that in these respects they present an unfavorable contrast with English suburban residences. *Garden and Forest* (July 8) criticises the *Cosmopolitan* article, basing its criticism not upon any defect of style, or upon any lack of soundness in the opinion expressed, but upon a failure to comprehend the root of the difference pointed out. Mr. Sturgis appears to think the more retired, homelike, and dignified aspect of English suburban and rural houses results from greater attention to their surroundings. The English garden is made the subject of warm praise, and its influence upon home life is presented in attractive form.

Another reason for the more conspicuous character of American rural architecture, deprecated by Mr. Sturgis, he finds in the extensive use of wood as a material for building in the United States. The air of superior permanence and stability which is one of the effects produced upon travellers by English, as contrasted with American, residences seems to this writer unattainable in wood construction. *Garden and Forest* speaks of the prevalence of wood building as compelled by economy, which, as yet, is an American necessity; but it demurs to the general applicability of Mr. Sturgis's proposition, denying that the fault charged can be justly attributed to the majority of American suburban houses, or that, when it exists, as it admittedly does in many cases, its causes are altogether, or even chiefly, such as Mr. Sturgis assigns.

"The main trouble is not with our material, but with the way in which we use it, preferring showiness to quietness, variety to harmony, over-elaboration to simplicity, loudness to modesty, evident costliness to a well-bred reticence.

"But the outer aspect of a house, while it may reveal the owner's character and thus give an insight into his probable habits of life, does not actually mould and determine these habits. They are more directly moulded and determined by the disposition of the interior of his house. It is impossible to lead a comfortable, sensible, profitably-occupied, quietly-amused, genuinely domestic life in a house that has been planned and furnished 'for show.' Many American houses seem to have been built rather as places which may be proudly exhibited to visitors, or in which troops of guests may be sumptuously entertained, than as places in which the occupants, each in his or her individual way, will find the needs and desires of personal existence agreeably and adequately met. They are as well fitted for occupation by one family as by another, and they are not really well fitted for occupation by any family which finds its best pleasures in hours of privacy and domesticity."

But the force of the contrast between the English and American suburban environment is freely admitted.

"The character of the life that is led in a suburban house is determined, at least for seven or eight months in the year, very largely indeed by the character of its grounds. If the grounds are not beautiful, the sense of beauty will be dulled and distorted in those who perpetually gaze upon them. If they are planned for display, as ministers to pride and vanity, the general mental attitude of the family will be unfavorably affected. If they are not well adapted to out-door repose or activity, and to the development of a personal interest in nature and her products, they will not be lived in; the days of the family will be passed indoors, or passed away from home; and the true enjoyments, like the true refining, softening, and cultivating influences of rural or semi-rural life, will be altogether missed. And, if the grounds are

adapted to out-door living, they must have a good measure of privacy—of seclusion. The English suburban place, says Mr. Sturgis, 'gives the householder quiet, rest, and retirement.' These are the results of separateness, protection, privacy; and it is their possession which fosters, not only the typical English love of nature, but the typical English form of domestic life, —reserved, intimate, and thoroughly domestic, yet hospitable in the best sense of the word, because the truest hospitality is that which admits the outsider into the most homelike home."

It is noted that the later colonial houses, as a rule, are set nearer the road than are the English, and that their grounds are more frequently at the rear than at the front of the house, while the English practice is the reverse. Privacy of the grounds is secured in the latter case by a wall between the road and the grounds. When the grounds are at the rear, privacy is secured by distance from the road and by the intervention of buildings. But, in considering this point, one recalls many glaring instances where grounds are in the front, and are laid out with the evident intent of affording a good view of the house from the roadway, in order to allow those who pass an opportunity for viewing and commenting upon the style of the occupants. This is the worst possible taste, and amply indicates the love of show which is a common characteristic of those who suddenly acquire the means for display. Such people are comparatively numerous in America, and they are egregious sinners against good taste in other things besides architecture. Refinement of taste appears to be a concomitant of wealth passed from generation to generation, and can hardly be expected to be the rule yet in a country only a little more than a hundred years old, more than half of which has been redeemed from the wilderness state during the last fifty years, which has largely been settled by the lowest classes from foreign lands, and in which sudden acquisition of wealth by the few has been a social phenomenon during the last thirty years. One may acquire dollars rapidly, but good taste is of slow growth. And, in a land of parvenus, is it worth while to quarrel with the very natural desire of the parvenu to announce, in the only way possible to him, his emergence from poverty into wealth? We must wait for art and taste till the parvenu age in social formation is succeeded by the slow deposit of another stratum.

Facts About Plumbing.

THE LANCET (London), having selected a special commission to examine and report upon the relative efficiency and cost of plumber's work, published the report as a supplement to its issue of July 4. The facts that this paper is a medical journal and that the information sought was collected in the interest of sanitary science rather than with a view to benefit the trade of the plumber do not, however, render the report less valuable to architects, builders, and plumbers. On the contrary, it contains much that is of special importance to those engaged in the practice of these arts.

The architect is first mentioned in this report, and the wide range of qualities and qualifications necessary to the successful practice of his honorable profession are named. An architect should have considerable scientific knowledge, be sympathetic that he may readily assimilate the ideas of his clients, and have good administrative capacity. The use of such a man "simply as a taskmaster to wrest and screw work out of the contractor," as the report says is now done, is denounced as "nearly equal to the employment of Michel Angelo in moulding an image of snow."

The report holds that the interests of the architect and the builder, as far as possible, should be one, and not, as is too often the case at present, opposed. If a stranger to the system were to take up an ordinary memorandum of agreement to be signed by the contractor for the execution of some small contract, say for £1,000, the first idea would be one of surprise that a man who required to be so much controlled as this contractor should be employed at all. The contractor is evidently branded as a dangerous rogue,

who will try every dodge, even to taking refuge in the bankruptcy court, in order to avoid the proper execution of the work. Nay, more, he must sign away his birthright in many cases, and the architect's or arbitrator's ruling must have the force of a rule of court. Against this somber background the character of the architect, shown in a few light touches, stands out in pleasant relief. In the course of this inquiry it has become apparent that the contractors are themselves much to blame for their anomalous position. In their anxiety to obtain work it is undertaken at prices which would yield no profit if efficiently executed, irrespectively of possible errors in calculation. There is the chance that something may occur to upset the contract, and in that event they may continue the work upon better terms; or, again, they may have a quantity of machinery that would stand idle unless the work were obtained, in which case their loss would be still greater. If a contractor enters upon work upon either of these conditions, the natural tendency is to seek relief by "scamping" it in some form. The effect that this has upon the architect is very marked.

As to the information obtained by architects with reference to prices, it is stated that "this comes to them at second hand," that it is made up from schedules of lowest prices in previous bids for contract work, that it is an average of these prices which forms the standard, and that this standard "cannot be taken as proof of the real cost of work properly carried out." Especially in the case of leasehold property does the system now in vogue have bad influence upon plumbing work. The architect reasons that the work need not be of a very lasting character, so far as his client, the lessee, is concerned, and proposals for the performance of work at "cut" prices (resulting, as a matter of course, in inferior work) are readily entertained. The contractor is cut down in price to the finest possible figure. The master plumber particularly suffers from this, as contractors now either employ men directly, or occasionally sublet to the master plumber the work, while absorbing a part of his profit. The master plumber at one time could rely upon keeping a certain staff of picked men in constant employment. Now the contractor generally discharges the men directly they have completed the work in hand, and with this knowledge much of the interest the men formerly had in their work and their employer ceases. The tendency to cut down prices beyond a certain point leads to bad work. There is a great distinction between healthy and unhealthy competition.

The sum of the conclusions reached appears to be that the art of plumbing has been so greatly advanced that the presence of inferior work in any recent construction is, in all probability, an indication of an effort to cheapen its cost below reasonable limits. This practice has given rise to the unhealthy competition prevailing throughout the trade. Here again the fault is referred back to the architect.

"The architect who is competent to arbitrate upon a builder's account is also competent to say whether an estimate is fair and reasonable without pitting a number of men one against another. Where the architect exercises this power the best work is done, the inducement to scamp work being removed, and that to carry out the work satisfactorily remains, as there is a reasonable hope of future work being obtained from the same architect. If, on the other hand, the architect's client hopes to gain an advantage by the mistakes or necessities of others, the present system of competitive contracting affords him every prospect of attaining that end. Such competition, however, tends more towards a low price than efficiency, the contractor knowing that, no matter how well he may execute the work, it will not insure him other employment from the architect, unless his tender is again the lowest. That the quality of the work suffers is well known, as board schools and other buildings have been erected with drains unconnected with the sewer, or other omissions of an equally injurious character. It is, indeed, to the credit of the professional men who administer such a system that so large a leaven of latent honesty still remains undemoralized in the trade itself."

Finally a remedy is suggested,—to wit, an agreement upon standard prices for plumber's charges, and a properly qualified board of arbitrators to which, at little cost, an appeal may be made by either side. The present status too often creates a sort of duel between the architect and the contractor employed, "the latter endeavoring to make a surreptitious profit by evading or 'scamping' his work, though the same is included in his contract or account. In the end the architect's client often pays a good deal more than ten per cent. profit upon the work actually done, but the quality is inferior, and every person connected with the transaction has been more or less demoralized."

Wind Pressure.

THE ENGINEERING RECORD (June 6) made the St. Louis tornado and its disastrous effects the occasion for again alluding to the meager knowledge of this subject possessed by the engineering and architectural professions. The difficulties that here beset original investigation are admitted and well indicated.

"Long columns, timber beams, and plate girders may easily be tested to destruction, and be made to yield complete data necessary for the best design; but an artificially destructive wind-pressure acting against a building or a bridge is not so easily arranged for, setting aside all questions of cost. The incidental problem of the relation between wind-velocity and pressure is shrouded with almost or quite as much doubt, in spite of the fact that the weather bureau of the United States government uses a table of relations in which the pressures per square foot for stated velocities are given to hundredths of a pound. Incidentally it would be interesting to know how such values have been established in the absence of direct tests.

"The results obtained by Sir Benjamin Baker on his surface of three hundred square feet, at the site of the Forth bridge, as well as on the smaller surfaces he employed, are, of course, well known, and they constitute nearly all the experimental, quantitative data of value which we have; yet their range is not large, and they leave the greater part of the problem unsolved. Indeed, the securing of the desired data in anything like completeness is necessarily a slow process, for the reason that actual winds, as they blow, must be employed. The best and, one might say, the only opportunities offered for these investigations are just such disasters . . . as that which visited St. Louis. This last one was far more destructive than that which passed over the same locality about twenty-five years ago. At that time the wind turned over a locomotive, and Mr. C. Shaler Smith, with the analytic acumen which characterized so much of his work, was quick to use the incident to demonstrate that the pressure acting could not have been less than ninety-three pounds per square foot."

The suggestion is then made that the portions of the timber roadway blown off from the Eads bridge, and the portions of masonry which were blown down, might supply the needed data for the computation of the wind pressures that effected these results, were they treated by the method employed by Mr. Smith in the case of the overturned locomotive. The ability of civil engineers in St. Louis to deal with any such question is complimented, and the suggestions are commended to their careful consideration.

The conclusion of the article voices a feeling of insecurity relating to modern tall buildings, which many have entertained, for the most part, rather vaguely. The great tornado did not exert its full violence on any of this class of structures. None of them lay in the path of its greatest intensity. What might have happened had the same force been exerted upon any of them as upon the bridge is purely a matter of speculation. Evidently *The Engineering Record* thinks there is grave room for doubt that all of them are of a character to withstand such a trial of strength.

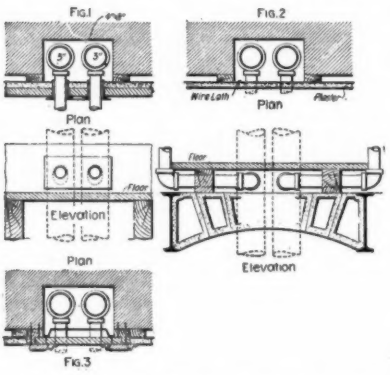
"Some high grain elevators and flour mills were destroyed, but no information is given as to their design or construction. The modern tall building has yet to be subjected to these intense wind tests. Where properly designed and constructed,

we believe there is little to be apprehended, but destructive wind pressures like those at St. Louis, Louisville, and other places, demonstrate that those who indifferently recognize or, worse, neglect wind effects of high intensity in their designs, invite disaster, and in some cases will probably secure it."

Pipe Chases.

THE illustrations herewith presented of methods of forming pipe chases for heating mains are reproduced from *Engineering News* (July 18).

The illustrations were presented in an answer to a correspondent who wished information upon the methods in use, and also upon means in use for affording access to heating pipes after their erection. The usual size of a chase called for on architects' plans is eight inches in breadth and four inches in depth of the recess. "Figure 1 shows one of the methods of constructing these. The furring strips are nailed to the wall, to which are fastened the wire lath, and on top of this the plastering is laid. The figure shows the section taken through the baseboard. When the piping is carried above the flooring, holes are sometimes cut through the baseboard and plastering, and a metal sleeve, the outer edge of which is flanged, is pushed into the holes. This metallic sleeve is elliptical in section, with its longer axis in a vertical position, to allow the risers to expand. Frequently a sheet of metal, with small holes in which the horizontal branches fit tightly, is placed over the front of these elliptical openings, the metal sheet being of such a size as to entirely cover the elliptical opening, whatever may be the position of the branch in it. Where steel construction with hollow tile or masonry arches is used, the flooring is generally nailed upon sleepers about four inches in height. You have to carry the steam pipes in this space, holes being cut in the sleepers where the pipes pass through them. In both of these instances the pipe chases are not accessible, unless the plastering, wire lath, etc., are removed.



"Figure 3 shows another form of construction. On either side of the pipe chase a wooden 'ground' is nailed to the side wall, and the thickness of the abutting furring strip, wire lath, and plastering is such that the latter will come flush with the outer face of the ground. The ground is recessed so that a panel reaching from the floor to the ceiling may be inserted. Frequently a finish consisting of some appropriate molding is nailed on to the ground, and also to the panel. Against the inner face of the panel a tin back should be nailed to prevent the radiant heat from reaching the wooden panel. Frequently, however, a register is placed in the top and bottom of the panel to maintain a circulation of air through the chase. Where this is done, the tin backing is sometimes omitted."

Wired Glass in Fire-Resistant Windows

ONE of the latest materials for building construction is called wired glass, which takes its name from the fact that the panes or sheets are formed upon wire netting imbedded in the body of the glass. Some of the usual effects of sudden, or of prolonged, heating, and sudden cooling,—as by water thrown upon hot glass in extinguishing fires in buildings,—are by this means avoided, and the material seems likely to come into extensive use for skylights, windows of warehouses, and, in short, generally for windows where the outside appearance is of little or no importance, and wherein resistance to fire is of great moment.

The opinion here expressed is based upon some recent tests of the fire-resistant quality of wired glass, made under the supervision of Secretary Charles A. Hexamer, and Inspector William McDevitt of the Philadelphia Fire Underwriters' Association.

In these tests (reported in *Monthly Report of the Boston Mutual Fire Insurance Company* for June) a brick building nine feet high was erected and provided on one side with a pitch roof of wired glass. Side-windows and a glass door, with wooden frames encased in tin, were also placed in the building. Draft holes for free entrance of air were left at the bottom of the building. The structure was filled to the height of six feet with rosin saturated wood. One side of the pitch roof was made of ordinary rough-surfaced glass, such as is commonly used for sky-lights. The roof glass was supported by metallic frames.

Upon firing the wood the ordinary glass broke and fell in five minutes. On the other hand, the wired glass, although the heat was raised to a degree that cracked the brick walls, and charred the tin-covered window frames, retained their integrity throughout the test.

The rationale of the greater resistant power of the wired glass is that, when the glass cracks, as it does at first, the fragments are retained in position by the wire netting, until they fuse and are cemented together again. The fusion of glass occurs at a temperature below that of the fusion of wire, and, the glass being a poor heat conductor, each protects the other.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Architecture and Building and Allied Subjects in the American and English Architectural and Engineering Journals—See Introductory.

Construction and Design.

*7005. Construction in Earthquake Countries. John Milne (The series is based upon building regulations and experiences from nearly every earthquake shaken country in the world, and the study of thousands of ruined buildings in Japan). Engng–July 3 Serial. 1st part. 3400 w.

7019. The Design of Steel-Skeleton Buildings (Some contributions to the history of this construction by architects and engineers who are familiar with the work, called forth by the query of F T. Gates, in regard to the originator of this construction). Eng Rec–July 11. 2000 w.

7021. The Standard Block, New York City (Illustrated description of foundations, plan, location of piers, details of caissons, derrick and general elevation of a building which will be constructed and equipped in conformity with advanced practice for fire-proof steel-cage office buildings). Eng Rec–July 11. Serial. 1st part. 1500 w.

7022. The Buffalo, N. Y., Building Ordinance (Extracts from the new building law of named city with adverse editorial criticism). Eng Rec–July 11. 3500 w.

*7025. Should Architectural Competitions Be Abolished or Regulated? (Extracts from papers by Mr. John A. Fox, Mr. R. D. Andrews and Mr. H. Langford Warren, which have the approval of the editor). Brit Arch–July 3. 1500 w.

7026. Self-Helps. C. H. Blackall (A suggestion of ways in which architects may improve constantly in their work). Am Arch–July 11. 2500 w.

7027. Salisbury Close. A. B. Bibb (Illustrated description of the cathedral and houses about the Close). Am Arch–July 11. 1300 w.

7028. The Action of Heat on Cement. J. S. Dobie (A paper read before the Eng. Soc. of School of Prac. Sciences, Toronto, Canada. In the interest of fire-proof protection, showing what may be expected from a mass of concrete or cement when subjected to great heat). Am Arch–July 11. 2300 w.

*7030. Selby Abbey (Illustrated description). Builder–July 4. 2500 w.

*7038. Ecclesiological Notes from North Germany. T. Francis Bumpus (The German pointed architecture as exemplified in the buildings of Westphalia, and the architecture of Belgium and the Rhineland. An account of a trip for study, by the writer. The first part treats of Aix-la-Chapelle and Neuss). Arch, Lond–July 3. Serial. 1st part. 4500 w.

*7072. The Owen Jones Student 1895 · His Notes and Impressions in Italy. John J. Joaso (Description of a town containing interesting architectural information). Jour Roy Inst of Brit Arch–June 25. 5000 w.

7155. "Oracle" Cottage Contest (A competition to show what could be done with a limited amount of money. Illustrated description of the first and second prizes of a cottage not to cost over $1250). Arch & Build–July 18. 400 w.

7170. The Château de Blois. W. T. Partridge (A brief history of the château. Part first describes the approach, the façade, the court yard, and the wing of François I). Am Arch–July 18. Serial. 1st part. 2000 w.

We supply copies of these articles. See introductory.

*7173. Canterbury Cathedral (From the *Daily Chronicle*. Remarks on the present state of the cathedral of Canterbury. An appeal for needed repairs). Arch, Lond-July 10. 2c00 w.

7184. The Era of Better Buildings in New Orleans (The improvement of business buildings in the last few years is briefly noticed, with illustrations of two buildings). Mfrs' Rec-July 17. 1000 w.

7245. Recent Changes in Structural Shapes of Rolled Steel. F. E. Kidder (Table giving the standard weights for beams and channels, and the weights and areas of the standard sizes of angles, as adopted by the Assn. of Am. Steel Mfrs., with additional information). Arch & Build-July 25. 800 w.

7285. Plate-Girder Construction for a Large Church Dome (Illustrated description of the construction of Christ Methodist Church, Pittsburg, Pa.) Eng Rec-July 25. 350 w.

*7312. The Halifax New Infirmary (Illustrated description with information regarding the selection of location, plans and costs). Arch, Lond-July 17. 2500 w.

*7313. The English House (A review of the process of evolution which has produced the house of to-day from the primitive hut of the early Briton). Ill Car & Build-July 17. 3200 w.

7349. Monument Erected on the Kyffhauser in Honor of Emperor William (Illustrated description). Sci Am Sup-Aug. 1. 1000 w.

7350. Græco-Phœnician Architecture in Cyprus (Epitome of a paper read by Dr. Max Ohnefalsch-Richter, before the Royal Inst. of British Architects). Sci Am Sup-Aug. 1. 1300 w.

*7420. Building a Greenhouse (Discusses their need of paint, material for roofs, the roof plate, and the ridge pole). Ill Car & Build-July 24. 1300 w.

*7449. "Friedrichshof," near Homburg (Illustrated description of the new home of the Dowager-Empress Frederick of Germany, the Princess Royal of England). Builder-July 25. 2000 w.

7509. Underpinning the Stokes Building, New York City (The problems that arise in the erection of the tall and heavy buildings in lower New York, are considered, and a description of the work named, with illustrations, is given). Eng Rec-Aug. 8. 3800 w.

7510. A High-Duty Pump and Elevator System for a Warehouse (Description of the plant, and of the pump, with the results of its economy test, in the building known as Cupples Station, in St. Louis, Mo. A system of 52 elevators, doing heavy work. The system is worked under a pressure of 750 lbs). Eng Rec-Aug. 8. 1400 w.

*7521. Optical Refinements in Mediæval Architecture. William H. Goodyear (Report of the Brooklyn Institute Survey. The source of the picturesque in mediæval building; cause of inferiority of modern architecture; a study and discussion of the construction, &c). Arch Rec-July-Sept. Serial. 1st part. 5000 w.

*7522. Modern Hospitals in Europe. Alphonse de Calonne (Interesting illustrated description of the architecture, or system of arrangement, in European hospitals, with the improvements introduced in the modern buildings). Arch Rec-July-Sept. 8000 w.

*7523. Dr. William Thornton, Architect. Glenn Brown (An interesting biographical sketch, and the connection of Dr. Thornton with the history of Washington city. His career as an architect and his work, with many illustrations, including his design of the Capitol). Arch Rec-July-Sept. 4800 w.

*7524. Authority in Architectural Design. John Beverley Robinson (The restrictions placed on architects in this country, with causes. The æsthetic sense of the French, and their achievements in architecture; criticism of American architecture, with discussion of best means for correcting its faults). Arch Rec-July-Sept. 3500 w.

*7525. Architectural Aberrations.—The Salvation Army Building in New York (Severe criticism of the structure (Arch Rec-July-Sept. 1200 w.

Heating and Ventilation.

7023. Heating and Ventilating of a Bank Building (Illustrated description. Indirect hot-water heating. Forced circulation of air). Eng Rec-July 11. 1100 w.

7104. Ventilation of the National Capitol. J. G. Dudley (An interesting description of plant which was designed by Gen. Meiggs, and has been in operation for more than thirty years). Heat & Ven-July 15. 2000 w.

7109. Heating and Ventilating of the New Masonic Temple at Albany, N. Y. (Illustrated description). Eng Rec-July 18. 800 w.

*7122. Ventilation for Residences (The neglect of architects to consider ventilation in plans for residences is criticised). Dom Engng-July. 900 w.

7414. Combined Warming and Ventilation of Public Buildings. J. D. Sutcliffe (Read before the Manchester Society of Architects. Consists of an introduction and discussion of warming by direct and indirect radiation; three systems of central heating; reasons for adopting the warm air system; warming and ventilation without mechanical power; mechanical ventilation; with description of some installments and practical hints). Arch & Build-Aug. 1. 4800 w.

7418. Heating System in an Extensive Country Residence (Illustrated detailed description). Eng Rec-Aug. 1. 2000 w.

*7439. Ventilation (The statement of requirements is regarded as much more simple than their satisfactory fulfillment. The injurious principles given off in expired air are grouped as carbonic impurities, as distinguished from carbonic acid, which, were it the only impurity, would not generally be present in injurious quantity). Arch, Lond-July 24. 1600 w.

Landscape Gardening.

7076. English Gardens Unsuitable for America (Editorial suggested by articles in *The Cosmopolitan*, by R. Clipston Sturgis, giving reasons why gardens in America must differ from the English). Gar & For-July 15. 2000 w.

7156. Forestry at Biltmore (Some information regarding the methods employed on the estate of George W. Vanderbilt). Arch & Build–July 18. 1000 w.

*7239. Old Time Flower Gardens. Alice Morse Earle (Descriptive of old fashioned gardens, especially those of colonial times, with many beautiful illustrations). Scribner's Mag–Aug. 5000 w.

7314. Delights of a Rough Garden. D. H. R. Goodale (A plea for a garden in which neatness is not the first essential). Gar & For–July 29. 1000 w.

7315. The Hardy Plant Border. Edward F. Canning (Description of plants that do well in this position). Gar & For–July 29. 700 w.

7316. Some Good Annuals. Robert Cameron (Descriptive of numerous flowering plants which may be effectively placed, with suggestions of location). Gar & For–July 29. 1200 w.

7453. Suburban Homes. Sylvester Baxter (An article suggested by the criticisms published in this paper, of a paper by R. Clipston Sturgis, in the *Cosmopolitan*). Gar & For–Aug. 5. 2200 w.

Plumbing and Gas Fitting.

*7174. The "Lancet" Commission on Plumbing (Report dealing with the qualifications of architects; standard of prices, how formed; arbitration; healthy and unhealthy competition; the plumbing expert; question of cost, and plumber's profit and loss account). Arch, Lond –July 10. 2500 w.

7286. Plumbing in the Hotel Jefferson, Richmond, Va. (Illustrated description). Eng Rec–July 25. Serial. 1st part. 1600 w.

7493. Scranton, Pa., Plumbing Ordinance (Complete copy of the new plumbing ordinance proposed at Scranton, which is considered exceptionally well written and deserving of adoption without material alteration). San Plumb–Aug. 1. 3000 w.

Miscellany.

*7016. Practical Sanitary Science. William H. Maxwell (Information of interest connected with ventilation, calculation of areas, water and water supply, plumbing work, removal of refuse, etc. First part treats of ventilation). San Rec–July 3. Serial. 1st part. 2500 w.

*7031. Rural Drainage (The first part is preliminary and discusses definitions, statutes, etc). Builder–July 4. Serial. 1st part. 1300 w.

*7121. Country Houses and the Disposal of Their Sewage (Address by George E. Waring before the Metropolitan Club, New York. Principles governing the work at the present time. A plain, practical treatment of the subject). Dom Engng–July. 3500 w.

*7150. The General Character and Properties of Sandstones. T. C. Hopkins (Descriptive of varieties of sandstone and their uses). Stone–July. 2500 w.

*7171. Tests of Canadian and English Brickwork (Illustrations and some particulars of tests of common brick conducted by C. H. C. Wright and his assistants at the School of Practical Science, Toronto). Can Arch & Builder–July. 1700 w.

*7172. Talks on House Painting (Calls attention to the fact that it pays to have painting done as well as possible). Can Arch & Builder–July. 1800 w.

*7175. A Hausmann for London (From the *Telegraph*. The subject of municipal embellishment. Its financial returns. The beauty of Paris, Berlin, and other cities, and the needs of London). Ill Car & Build–July 10. 1200 w.

†7192. Architecture and Decorative Art at the Art Institute of Chicago. P. B. Wight (Review of the work of the Art Institute of Chicago for the past year and subjects connected). In Arch–July. 2000 w.

†7193. A Rambler (Travels in Baltimore, Washington and along the Potomac, giving impressions of architecture, monuments, etc). In Arch–July. 3800 w.

*7244. Damascus. From *Baltimore Sun* (Its history and architecture). So Arch–July. 2000 w.

*7246. The Preservation of the Coptic Antiquities in Egypt. Somers Clarke (Paper read before the Soc. for the Protection of Ancient Buildings, with discussion. A study of Coptic church architecture). Builder–July 18. 7000 w.

7368. The Legal Duties of Engineers and Architects. Jas. C. Bradford (Condensed from an address delivered before the Engineering Assn. of the South. The importance of the duties and functions of architects and engineers). Eng News–July 30. 2300 w.

†7401. The Fire-Retarding Qualities of Wired-Glass. Charles A. Hexamer (At the request of the Mississippi Glass Co., which controls the manufacture of wired-glass, the writer, in conjunction with Inspector William McDevitt, made a series of tests of the fire-resisting qualities of wired glass. The main test is described in report given. Also report of test made in Boston is given. Illustrations). Jour Fr Inst–Aug. 2200 w.

*7419. The Churches of St. Petersburg (Describes St. Isaac's Cathedral, exterior and interior, and briefly refers to other structures). Ill Car & Build–July 24. 2700 w.

7422. Church Organs and Organ-Cases (Translated by F. G. Lippert from a paper prepared by order of the Union of German Church Organ Builders, and published in the *Deutsch Bau-Zeitung* of Berlin. Injurious practices of architects that injure organs, and calling attention to evils encountered in furnishing organs for new church edifices). Am Arch–Aug. 1. 2500 w.

*7480. Government Tests of Building Material (Report of important tests of building material made at the Watertown Arsenal, Mass., with the two principal objects of ascertaining the strength and acquiring a knowledge of the durability). So Arch–Aug. Serial. 1st part. 1300 w.

7489. Preliminary Report of the Committee on Tests of Fireproofing (Progress made to date in the work of the committee. Gives results of tests of unprotected columns, with illustrations). Eng News–Aug. 6. 2200 w.

CIVIL ENGINEERING

For additional Civil Engineering, see "Railroading" and "Municipal."

Earthquakes and Engineering Construction.

MR. JOHN MILNE'S paper on "Construction in Earthquake Countries," in *Engineering*, affords a striking instance of the success attained, by an intelligent application of scientific methods, in coping with a commonly-considered uncontrollable force of nature. Not that earthquakes have been harnessed or reduced to rule and order, but that much has been done, by a careful study of their phenomena, to determine their more dangerous tendencies, to provide means of lessening the risk by avoiding the conditions proved to be the most destructive, and to reduce largely the risks which must still be met.

It has been found by seismometric observations, and by a careful examination of the results of shocks in earthquake countries, that certain districts of maximum effect can be marked out. The first of these, as stated by Mr. Milne, is that "high, hard ground suffers very much less disturbance than soft, low ground." "Marshy, wet ground, which is popularly supposed to absorb earthquake motion, is notably a bad foundation. Experiments show that, although the period of motion is lengthened on such ground, the advantage thus gained is more than counterbalanced by the enormous increase in amplitude."

This is quite contrary to the usual belief, but is so well recognized that in Tokio the city is clearly divided into two districts, of differing danger, the higher being much the safer; in Manila, special building regulations govern the structures erected on low ground, and in Ischia the erection of dwellings in certain defined areas of loose ground is absolutely prohibited.

A second and more obvious principle is "that all steep slopes covered with alluvium are dangerous," the tendency being, of course, for the loose covering to slide away. "A third class of localities fraught with danger is the upper edges of cliffs, scarps, and natural or artificial open cuttings," because "the materials adjacent to the free face, being unsupported on that side, swing forward beyond the limits of their cohesion, and separate from that which is behind."

Next to the avoidance of situations of especial danger come the provisions for minimizing the risk upon the more slightly affected ground which must be occupied. These naturally relate chiefly to foundation construction. "The Ischian regulations provide that buildings must be founded upon the more solid ground. If, however, the ground is soft, a platform of masonry or cement should be formed" .7 meter thick for a one-story building and 1.2 meters for a two-story building, extending from 1 to 1.5 meters beyond the wall. "In Manila it is stipulated that the foundations must be able to bear at least twice the weight that is to be placed upon them. When the soil is bad, it must be piled, or consolidated by a bed of hydraulic concrete, and the foundation of a building must, as far as possible, be made continuous," the idea being that the "building which stands upon a continuous foundation sufficiently well bound together to move as a whole suffers less racking than if it rose from a base the different parts of which might be simultaneously moved in several different directions." Further, as it is found that the movement in piles 10 to 20 feet deep is less than that upon the neighboring surface, "it may be concluded that a building rising freely from a dry foundation . . . will be subjected to less movement than one rising directly from the surface." This is, indeed, exemplified by certain of the Imperial University buildings in Tokio.

Quite the opposite of these means is the next suggestion of minimizing the motion by giving a building free foundation,—that is, resting pier foundations on plates carried in turn on cast-iron shot, or short

rollers placed at right angles, trusting to the inertia of the building to maintain it at rest while the ground beneath moves rapidly to and fro. This, however, although it has given satisfaction in certain cases, is suggested by Mr. Milne as probably applicable only to small, light structures; it is, moreover, "ineffective in resisting vertical displacements, or the effects of rolling which accompanies strong undulatory motion." It would not seem adaptable to any heavy engineering construction, which must depend on depth and strength of foundation and, possibly, elasticity of superstructure.

The New Tehuantepec Railway Concessions.

THE importance of the interoceanic route across the southern border of Mexico, from the Gulf of Campeachy to the Gulf of Tehuantepec, which was so effectively treated by Mr. E. L. Corthell in THE ENGINEERING MAGAZINE some time since, is recalled by the notice given in *The Indian and Eastern Engineer* to the new activity infused into the enterprise by recent action of the Mexican government.

Messrs. S. Pearson and Sons, according to this report, "have secured a lease of the Tehuantepec railway" and "entered into an obligation that is huge even in these days of gigantic undertakings." The undertaking is not clearly defined in the report, but is understood to involve ballasting the line, replacing timber bridges and culverts with iron and masonry, creating an artificial port at Salina Cruz on the Pacific side, and improving the harbor of Coatzacoalcos on the Gulf of Mexico. The harbors alone are expected to cost about $10,000,000,—a large increase over the estimates for Mr. Corthell's project in 1894, which contemplated the expenditure of less than $6,000,000 on the harbors and only $8,000,000 for the entire work, including the completion, improvement, and equipment of 190 miles of railway.

The work mapped out, however, appears to be much the same, and consists principally of dredging the bar and constructing jetties to maintain the channel on the Gulf side, and building a breakwater and deepening the area within it on the Pacific coast.

The writer in *The Indian and Eastern Engineer* (who acknowledges, in a general way, indebtedness to Mr. Corthell for information) reminds his readers that the new route will reduce the time of a sea trip from New York to San Francisco to twenty days, and from San Francisco to Liverpool to twenty-nine days, and predicts an "influence on British trade which it is impossible to overestimate," though the reason for the national limitation is not evident, and the case is better stated in the preceding broad proposition that the enterprise is "international in its scope and of the greatest importance to the development of the commerce of the world"—perhaps "destined, so far as the Mexican isthmus is concerned, to solve the problem of communication between the Atlantic and the Pacific coasts."

"French corruption, on the one hand, and American incapacity, on the other," are unkindly coupled as causes rendering "impossible, for the present at all events, the construction of either the Panama or the Nicaragua canals, and thus it happens that this railway has been left to provide for the great and growing requirements of the traffic between the west and the east."

"Has been," however, is a little premature; the completion has not yet gone into the past tense, and a singular series of failures attended the former efforts. The first concession—to Edw. Learned in 1878—was terminated when only thirty-five kilometers of railway had been built. Several successive private ventures failed; so did the contract with Delphin Sanchez. The next contract,—with Edward McMurdo of London,—involving only the railway without the terminal works, was not carried out, "partly through the death of the concessionaire and partly through other causes." What remained of the fund obtained from the bonds issued for the McMurdo contract was given to a firm made up of Messrs. Stanhope, Hampson, and Corthell, to prosecute the work; finally, the junction of the two ends still being uneffected, another contract was made with Mr.

Stanhope, and the line completed in somewhat temporary form in 1894.

It took another million dollars in gold and upwards of two and a half millions in Mexican silver (in addition to the million and a quarter of silver and over four million pounds sterling in gold already expended) to provide, under contract with Messrs. Hermances, "equipment and some permanent structures;" and still "ballasting has yet to be done, and the timber bridges replaced by iron and masonry."

The greatest credit belongs to President Diaz for his faith in the enterprise and his boundless perseverance through so many disappointments. It is much to be hoped that the present contracts, under which work is said to be making "really splendid progress," will indeed complete the entire project.

Bridging the Mississippi at New Orleans.

THE importance of the Tehuantepec trans-isthmian route to American commerce was fully recognized by Capt. Eads: "We must next discharge the commercial volume of the Mississippi into the Pacific ocean," he said, the "next" being subsequent to his magnificent success in making the lower Mississippi an open highway for cargo-carriers of all classes. How far the creation of this great thoroughfare of trade has resulted in a conveyance of traffic lines at its portal is well set forth in the *Manufacturers' Record* in its New Orleans supplement.

In 1876 the total tonnage entering the port of New Orleans was 1,908,114; in 1892-1893 (the latest date of detailed information) it was 3,333,658, and by far the greatest increase was in the largest class of vessels.

The attendant growth of railroad traffic, related to the receipt and reloading of this freight, has swelled the number of cars handled at the city from 151,332 in 1880 to nearly 550,000 at the present time, and has converted New Orleans into a center concerning which Mr. E. T. Jeffrey of the Illinois Central said a few years since: "no other city of the world—and this may seem like a broad assertion—through its systems of railway covers so directly and without the use of systems reaching rival cities so vast an area of productive territory."

The free and advantageous movement of this traffic about the city brings its own problems, and the very waterway which focusses the radiating lines becomes itself an obstacle to rapid interchange of railroad freight. To remove this difficulty, a bridge is projected to cross the river about four miles above the city; the charter was obtained in 1888, the site carefully selected, the plans approved by the secretary of war, all details worked out, and, according to the *Manufacturers' Record*, the structure itself, it is expected, will be ready for use in 1899.

"Nearly two years have been employed in working out the details of this immense structure, which is, in its proportions, far beyond any that has ever been built in the United States in the way of cantilever structures, and in some of its important features is entirely novel, especially in regard to the depth of water and the underlying material for the foundations."

The whole river-bed is of course deep alluvium, with no bed rock at any attainable depth for foundation purposes. There is, however, very fortunately, clean, sharp sand at very moderate depth, increasing in coarseness with increase of descent, and on this the foundations for the piers will be based, about 170 feet below low water.

"Caissons built of yellow-pine timber, firmly braced together, will support the masonry pier. The size of this caisson will be about 126 feet long and 60 feet wide, and will be 140 feet high. The caissons will be designed so that either one of two methods may be employed to sink them to their resting place, either by pumping out the sandy material of the bed by hydraulic process, or by dredging it by the dredging process through wells built in the caisson and also in the masonry above the caisson. It is expected, however, that, unless obstacles in the way of drift logs or wrecks of boats are encountered, the hydraulic process will be successful."

The bottom about the piers, and the banks near the bridge, will be heavily pro-

tected against scour, by willow mattresses and rip rap.

"The masonry piers resting on the caissons begin thirty feet below low water and rise ninety-six feet above this level. The masonry of these river piers will be twenty feet by fifty-four under the coping. They will be rectangular in shape from the top to within a foot of the high-water line, from which elevation to the timber work there will be a cut-water, or starling, on both up-stream and down-stream ends. The shore piers will be sunken either by the hydraulic process above described or by the plenum-pneumatic process, so well known to bridge engineers. The two shore piers, as they carry but little weight, will be much smaller than the main piers; they will be ten feet by fifty feet under the coping." The height will be eighty-five feet clear above high water.

The bridge is to be of the cantilever type, because the clear independent span of 1,000 feet required by the charter "was not considered practicable, or at least desirable, and, as the ground is so low and no wash exists in the entire country for anchorages, a suspension bridge was not practicable."

"The channel span will be 1,070 feet between centers of piers, or 1,044 feet in the clear at low water. It will be formed of two cantilever arms, each reaching out 270 feet from the piers and supporting a central span 530 feet long; the shore spans which act as anchorages of the cantilever arms are about 600 feet long; they are of such length and width that there will never be under any position of trainload any uplift at their shore ends. The outline of the top chord of the main bridge has been designed in graceful curves, rising from a height of 80 feet above the track at the center of the main span and ends of the shore spans to 160 feet above the river piers. On these piers are erected massive steel towers, formed of four posts firmly braced together."

"The river at the location is about 2,400 feet wide, a little less than half a mile. The entire length of the bridge and its approaches between the connecting points of the railroads on each side is about six and one-half miles. The length of the steel structure is a little over two miles, making it the longest in the world."

The New Lock at Sault St. Marie.

THE great lock in the canal around the rapids of the St. Mary's river has been formally opened for traffic; the lock formerly existing is still in use, and, it is understood, is to be maintained. It is not likely that navigation will again suffer such an obstruction and interruption as occurred in 1890, when the lock was damaged by accident, and a three-mile procession of delayed vessels congregated above and below before repairs were completed so that traffic could be resumed; but, in the event of such an improbability, a third route exists through the lock on the Canadian side.

To one unfamiliar with the conditions the triple provision seems unnecessary; but not to one who has witnessed the wonderful volume of traffic passing in both directions between Superior and the lower lakes. The converging lines from Michigan and Huron uniting in the Detour and passing through Hay Lake channel and the locks into the "unsalted seas" of the northwest assemble an aggregate of tonnage probably unparalleled in any artificial waterway in the world. The Sault canal has long outstripped the Suez in annual tonnage passed through, and in the fiscal year 1895 showed the magnificent figures of over 15,000,000 tons, valued at over $150,000,000.

Iron, copper, lumber, and wheat, or the products manufactured from them, are carried down; coal, machinery, groceries, and general supplies are returned in exchange; and the old town which was settled originally as a trading post at the "carry" around the rapids now centers about the modern counterpart by which the magnificent steamers of the new lake service are passed from deep-water navigation above to the deepened channels below the rapids.

The original lockage at this point was by a flight of two locks, built by the State of Michigan in 1855,—indirectly, that is, the work having been delegated by the

State to a company of eastern capitalists.

To these succeeded the single lock built by the United States in 1881, until recently the sole medium for both American and Canadian commerce. The gates of this lock closed a clear opening of 60 feet in width,—10 feet less than the old State locks; in the new lock just opened the width is increased to 100 feet, and the lock has a length of 800 feet.

It is provided with five sets of gates,—upper and lower guard gates in addition to the three gates properly belonging to the lock. Mild steel was the material employed for all five sets, for the reasons cited by *Engineering News* from official information as follows:

"Experience in France has shown that, at the present day, leaves approaching the size of those under consideration can be constructed much more cheaply of metal than wood. In the United States the cost of timber is not so great as in France, but it is continually increasing. If the gates of the new lock were to be made of wood to-day, they would need to be renewed in about twenty years, when the cost of timber would probably be so great as to compel the use of metal in the reconstruction, while the shape would have to correspond to the masonry and be still designed for the original wooden structure. Thus the shorter probable life of the timber gate, the difficulty in so assembling it as to carry its great weight rigidly without a roller, and the fear of trouble in future renewal caused the selection of mild steel as the material.

"Briefly described, the leaf is a steel structure having a framework sheathed on both sides with plates. It is curved in plain, the two leaves forming a continuous arch when closed. The upstream and downstream surfaces are portions of cylinders. The clear distance between the sheathing plates is 30 inches at the ends and 36 inches at the middle, this splay being given to make the interior more accessible and to allow for variations in the position of the curve of pressure. The body of the leaf is 43 feet high, surmounted by a footbridge 20 inches high, the top of which is level with the coping of the side walls. The chord of the leaf measured between the centers of the surfaces of contact at the quoin and miter posts is 56 feet 7.69 inches. The median circle measured between the same, a radius of 77 feet 3 38 inches, and subtends an angle of 42° 59′ 40″. With the adopted construction the depth of the gate recess from the inmost element to the plane of the face of the lock wall is 8 feet 7.13 inches. The weight of each leaf in air is 312,000 lbs.

"For uniformity and simplicity of construction the same form was adopted for all the gates, although the selection was originally governed by the great dimensions of the largest ones. The intermediate gate, 43 feet high, is a duplicate of the lower lock gate. The upper lock and upper guard gates are 26½ feet high, and are duplicates, and the lower guard gate is the smallest, being 25½ feet high.

2,404,657 lbs.	soft steel at 5.9 cts. per lb..	$141,874.76
119,168 "	high steel at 27½ " " " ...	32,473.28
36,167 "	cast steel at 9½ " " " ...	3,345.45
8,665 "	cast iron at 6 " " " ...	519.90
5,322 "	ph sphor bronze at 35c. per lb.	1,862.70
7,215 ft.	B. M. oak timber at $60 per M..	432.90
28	pumps and fittings.....	2,100.00
Total.....		$182,608 90

Esthetics in Engineering Construction.

IT is an encouraging sign of the times that beauty and dignity are gaining rapidly-increasing recognition as appropriate and, indeed, essential elements in important constructions of every kind.

It is not long since an award on competitive designs for a bridge was given to the competitor who had made it a point to consider esthetics as well as mechanics in completing his plans, and the reports appearing from time to time with reference to the new East River bridge give a lively hope that the commissioners will show at least as much wisdom and taste as was displayed by those in charge of a much less important structure in a much smaller town.

Washington bridge is a happy example of the result of collaboration between the artistic perceptions of the architect and the constructive ability of the engineer, and, while it may fall short of the perfection which might be reached by giving the artist a freer hand, it remains a splendid object-lesson in a comparatively new de-

parture deserving of high commendation.

It is understood, for instance, that the original plan contemplated solid masonry approaches, and that to the late Mr. C. Vaux belongs the credit for the substitution of the graceful and effective stone arches.

The original Brooklyn bridge is splendid in its proportions, and has that grace which, as Mr. Gardner remarked in the August number of THE ENGINEERING MAGAZINE, is the almost indefeasible attribute of a suspension bridge; but in detail it is bald in the extreme, and the approaches are beneath contempt. Indeed, it is an inexcusable abuse of a good word to bestow the term "approaches" upon the corrugated iron monstrosities which seem designed to obstruct as much as possible both view and access at both ends of the bridge. The Poughkeepsie bridge, on the other hand, is purely an engineer's bridge, deriving whatever severe beauty it may possess—if that be any—from the harmony of correct proportions in the members of each truss.

But, to quote Mr. Gardiner again, "he would be a dogmatic engineer who should say that there is but one right way in which the materials that form the girders of a steel bridge can be disposed," and "he would be an incompetent engineer who should say that, in choosing between the forms that lie strictly within the lines of utility and economy, beauty may not also be sought and found."

The public interest displayed in the new bridge and its approaches suggests that the day has gone by when construction committees or commissioners can perpetuate monstrosities upon the people who must live or pass in sight of their work. We are losing the spirit of reckless haste which would accept as a satisfactory public building anything which would keep out the rain, and demanded nothing from a bridge except that it should support the passing load. We are beginning to question even the valid right of the stand pipe to stick up in gaunt and hideous nakedness, like a chimney from the infernal regions, and even the building of a factory is no longer supposed to be utterly beyond the influence of some considerations of beauty.

And all these signs are healthy, for they indicate an increasing solidity of the national character. We are beginning to realize that we are here to stay, and are building to last; and our increasing exaction as to physical structures is a symbol of a tendency which will have its manifestation perhaps more stoutly, but no less surely, in demanding and securing greater stability and higher perfection in our social and political structures.

The Great Siberian Railway.

ACCORDING to the latest reports, orders have been issued by the Russian government to hurry forward the completion of the Siberian Railroad, so that through trains may be run two years hence. The route has been altered; instead of going *via* Kabarosk to Irkutsk, the line will cut across through Manchuria, to Chita, and thence to Irkutsk, effecting a saving of fifteen hundred kilometers.

A road which can save a thousand miles by a change of location indicates sufficiently its magnificent proportions, but the Siberian Railway presents other points of interest, besides being what is supposed to be so dear to the American heart, a "big thing"; it is modelled in general on American types of construction, although possibly (as the *Fortnightly Review* states) the immediate model studied by the Russian representative engineers was the Canadian Pacific railway.

The construction appears to be substantial, though rough, with a rail of moderately heavy section well spiked, and about twelve very substantial ties to the rail. The station buildings are surprisingly good; the intention is to leave the finer work of surfacing and alignment to follow, bending all energies at present to opening the line for through traffic — quite after American precedent.

Apart from its great length, the work presents few features of engineering importance, and, considering the conditions throughout, appears much less of an undertaking than any of our transcontinental lines. The common conception which

classes it as purely a military road is no doubt largely in error, and based upon mistaken impressions of the country traversed. The *Fortnightly Review* not inaptly styles Siberia "a Russian Canada," and the Russians themselves expect the opening of the line to develop remarkable natural wealth in the region the world has thought of as a dreary waste, but which is said to be rich in gold, silver, iron, coal, and lapis lazuli, and to possess opportunities for wealth in its fisheries, while there is no doubt that it has important agricultural possibilities.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Civil Engineering in the American, English and British Colonial Engineering Journals—See Introductory.

Bridges.

*6982. The Architecture of Bridge-Building. Ill. E. C. Gardner (Urging that more emphasis be laid upon esthetics in the construction of bridges). Eng Mag–Aug. 2800 w.

*7006. The Kistna Bridge, East Coast Railway, India. F. J. E. Spring (Illustrated description). Engng–July 3. Serial. 1st part. 2700 w.

†7063. A Concrete Foot Bridge. Arthur N. Talbot (Description of construction of a small foot bridge in the grounds of the University of Illinois, with discussion). Ill Soc of Engs & Surv –11 An Rept. 3500 w.

†7064. To Ascertain the Best Angle for Wing Wall of Bridge Abutment. John H Serviss (Concludes that the best angle for the wing is that which requires in construction the least amount of material consistent with stability). Ill Soc of Engs & Surv–11 An Rept. 500 w.

7090. Low Level Bridges in Queensland. A. B. Brady (Abstract of paper read before the Inst. of Civ. Eng. Illustrated description with statement of conditions that led to the use of these bridges). Eng News–July 16. 2200 w.

7210. Counterweighted Arch Bridge at Riesa (Illustrated description of bridge over the river Elbe having peculiarities in design and construction). R R Gaz–July 24. 1000 w.

7281. Widening an Iron Truss Bridge (Illustrated description of the changes to be made in the Washington Ave. Bridge, Minneapolis, Minn.) Eng Rec–July 25. 800 w.

7369. The Adopted Plans for the New East River Bridge (Drawings showing plan, elevation, and sections of what will be the longest suspension bridge in the world; and will have the longest span of any bridge save the Forth Bridge). Eng News–July 30. 400 w.

†7456. On Cantilever Bridges. Edgar Marburg (Historical and technical with diagrams, formulæ and practical remarks. Brief discussion). Pro Eng's Club of Phila–July. 5000 w.

*7478. Highway Bridges. Carl Gayler (Discusses a few points for improvement in the building of highway bridges, which may account for the limited success, and deals at some length with the present practice of structural engineers who have made highway bridges a specialty). Jour Assn of Engng Soc–June. 2800 w.

7481. The New Steel Arch Over the Niagara Gorge. Orrin E. Dunlap (Brief history of the present railway suspension bridge, followed by description of the new steel arch which is to take its place). Eng News–Aug. 6. 1700 w.

7488. The Coulouvreniere Concrete Arch Bridge, Geneva, Switzerland (Illustrated description of a concrete bridge of non-skeleton construction recently completed at Geneva, Switzerland). Eng News–Aug. 6. 1000 w.

7490. The Bridge Brake. Robert Grimshaw (Illustrated description of a device for preventing oscillations or undulations, applicable to almost any form of bridge construction). Eng News–Aug. 6. 1800 w.

7507. A Bascule Three-Hinged Arch (Description and figure of bridge designed by W. H. Breithaupt, to be built over Newtown Creek). Eng Rec–Aug. 8. 600 w.

Canals, Rivers, and Harbors.

7093. The Needs and Possibilities of Harbor Improvement at Chicago (A consideration of the more important engineering and commercial questions involved. Editorial). Eng News–July 16. 4000 w.

7209. The Improvement of the Delaware and Schuylkill Rivers. Walter Atlee (The paper gives some idea of the magnitude and difficulty of the work which has been accomplished describes the work and illustrates Philadelphia Harbor, gives costs and other interesting data). R R Gaz–July 24. 5000 w.

*7292. The Mammoth Hydraulic Dredge for the Mississippi River (Illustrated description of dredge and of the operation of dredging). Engng–July 17. 1400 w.

*7340. Rivers and Canals, and How They Serve Their Purposes (Review of work on this subject by L. F. Vernon Harcourt, with interesting extracts). Trans–July 17. 3000 w.

7363. The West Side Irrigation and Mining Canal in Wyoming and Colorado. Elwood Mead (Illustrated description The most interesting feature is the extent to which wooden pipe has been utilized). Eng News–July 30. 1600 w.

Hydraulics.

*7470. Movable Dams, Sluice and Lock Gates of the Bear-Trap Type Archibald O. Powell (Illustrated description of bear-trap gates, analyses, summary of equations for finding widths, application of bear-trap gates, etc). Jour Assn of Engng Soc–June. 11500 w.

We supply copies of these articles. See introductory.

*7471. Bear-Trap Gate in Davis Island Dam, Ohio River. William Martin (The difficulties encountered and their remedy). Jour Assn of Engng Soc–June. 1000 w.

*7472. Bear-Trap Gates in the Navigable Pass, Sandy Lake Reservoir Dam, Minnesota. Archibald Johnson (Description of the improved bear-trap, its main features, sheet piling, navigable pass gates, air bags and capstans, flumes, valves, etc., with illustrations). Jour Assn of Engng–June. 4000 w.

*7473. Marshall's Bear-Trap Dams. W. L. Marshall (General discussion and description, with mathematical analyses and illustrations). Jour Assn of Engng Soc–June. 7000 w.

*7474. Bear-Trap Weirs. W. A. Jones (Illustrated description of some new forms with practical considerations, analyses, etc). Jour Assn of Engng Soc–June. 4200 w.

*7475. Modified Drum Weir. H. M. Chittenden (Consideration of the modified drum weir; the principal difficulties in dealing with any of the bear-trap forms of movable gate are stated; and the advantages in this form are noted. Illustration). Jour Assn of Eng Soc–June. 1800 w.

*7476. Lifting Dam. Amos Stickney (The movable dam here described is one designed by the writer for closing the navigable pass at Dam No. 6, Ohio River). Jour Assn of Engng Soc–June. 1800 w.

*7477. A Design for a Movable Dam. B. F. Thomas (Describes a style of trestle applicable to any of the places now occupied by the Poirée trestle, and has the advantage of requiring a much less depth of sill for its protection). Jour Assn of Engng Soc–June. 800 w.

7483. Steel Lock Gates for 800×100 ft. Ship Canal Lock, Sault Ste. Marie, Mich. (Additional information, with illustrations, regarding the design and construction of these gates). Eng News–Aug. 6. 3000 w.

†7549. Flow of River Floods (A suggestion for investigation from the study of the landslip at Gohna). Ind Engng–July 4. 600 w.

Irrigation.

6998. Irrigation in Utah (Some interesting figures of results obtained as given in *The Utahnian*, having special reference to the work being carried out by the Mount Nebo Land and Irrigation Co). Eng & Min Jour–July 11. 700 w.

†7058. Sewage Irrigation for Profit. Walter C. Parmley (Discussion of the general irrigation question, and pointing out the conditions whereby even sewage may become a producer of wealth). Ill Soc of Engs & Surv–11 An Rept. 4000 w.

†7199 A Utah Attempt at Settling Contested Water-Rights W. P. Hardesty (Description of an attempt by Utah courts to secure an accurate and scientific measurement of waters that had been decreed to parties in dispute). Am Soc of Ir Engs–April, 1895. 1100 w.

†7200 Methods of Irrigation. F. P. Hallahan (Describes the two methods in general use, and favors the modern method). Am Soc of Ir Engs–April, 1895. 700 w.

Miscellany.

†7059. A Topographical Survey of the State of Illinois. John W. Alvord (Some of the advantages of such a survey and its probable cost, with discussion). Ill Soc of Engs & Surv–11 An Rept. 4000 w.

†7060. To Lay Out a One Mile Regulation Race Track. D. L. Brancher (Four diagrams are given with directions). Ill Soc of Engs & Surv–11 An Rept. 900 w.

†7065. Wagon Roads of Illinois. P. C. Knight (Calls attention to some common errors in road construction, with theories of the writer in regard to the improvement of dirt roads). Ill Soc of Engs & Surv–11 An Rept. 1000 w.

7089. A Proposed Standard Specification for Portland Cement (Extracts from an interesting paper by William J. Donaldson urging the adoption by the United States of a standard specification for Portland cement, the use of which should be required in all works done under the direction of officers of the corps of engineers, also, by the Navy, Supervising Architects' Office, etc. Conditions, reasons, and copy of specifications, with arguments are given). Eng News–July 16. 2200 w.

†7198. The Application of Photography to Surveying. John S. Dennis (Facts about results that have been obtained in Canada by the application of photography to surveying). Am Soc of Ir Engs–April, 1895. 2500 w.

7241. Record of Steam Shovel Work; Ann Arbor Railroad (Abstract of a paper read before the Mech Engng. Soc., by H. E. Riggs. Tabulated records of work done on the Ann Arbor R. R. improvements, for seasons of 1894 & 95, with a variety of steam shovels). Eng News–July 23. 800 w.

*7409. Origin and Use of Steam Road Rollers. E. Purnell Hooley (Abstract of paper read before the British Assn. of Munic. and County Engs. Reviews the history, and the working and general usefulness). Munic Engng–Aug. 5000 w.

*7410. Portland Cement Specifications (Reviews article by William J. Donaldson, urging the adoption of standard specifications; gives full abstract of the paper; also the Philadelphia controversy over Portland cement). Munic Engng–Aug. 6500 w.

7416. A Steel Coal Trestle and Pockets (Illustrated description of a steel structure, recently constructed in Rochester, N. Y., designed to receive coal from a train, store it in pockets or yard bins, and rapidly deliver it by gravity, automatically screened, to the retail wagons). Eng Rec–Aug. 1. 500 w.

7486. Road Building in Lancaster, Mass. Harold Parker (From the "Journal of Massachusetts Highway Assn" The conditions of the country and the methods used in keeping about 100 miles of public highway in good order). Eng News–Aug. 6. 900 w.

7506. The Strickler Tunnel (Built to increase the water supply of Colorado Springs. Map, profile of the tunnel location, view of the east portal of the tunnel and cross sections are given) Eng Rec–Aug. 8. 900 w.

ELECTRICITY

Articles relating to special applications of electricity are occasionally indexed under head of Mechanical Engineering, Mining and Metallurgy, Railroading, and Architecture.

Interior Wiring.

ALL of the electrical papers do not print articles of much practical value some of the time, but some of them present good practical discussions all of the time. Among those of a practical character for the current month we note one under the above title in *American Electrician* for July, in which methods of wiring are classed in two systems, the object in view for either system being the most uniform distribution attainable consistently with convenient accessibility and control of switches and fuses. We have reproduced on a somewhat smaller scale the diagrams illustrating these systems.

What is called the "cabinet" system is shown in Fig. 1. In this system the bus-bars are inclosed in a small cabinet, the feeding being done with a pair of mains, from which branch-circuits are established with the lamps or with "sub-cabinets," as illustrated in the diagram.

"The circuits are always controlled at the cabinets with a fuse, and often with a switch. These cabinets are cases built into the wall and finished in accordance with the wood work in the vicinity, and had best be arranged to lock, in order to prevent the intermeddling of curious or malicious persons."

The "tree," or feeder, system is illustrated diagrammatically in Fig. 2. In this system "large wires feed the center of the system, which consists of a pair of mains, and these in turn feed sub-mains, from which branch the taps supplying the lamps. This system is largely used in factories, machine shops, and weaving or carding rooms, where the lamps are so arranged that such a system is applicable, and where all of the lamps are to be used at once. For the majority of other places it is not suitable, except on a small scale."

But most frequently combinations of these two systems are employed, as in the modern tall office-building, wherein each floor is controlled at the dynamo switch-board by "feeding a cabinet located in a central position on the floor to be lighted, and from which the sub-feeders spread over the floor to supply the office circuits. First, there is always the main feeder, which carries the whole current used by the lamps. Then come the sub-feeders that carry the current of a portion of the lamps; and lastly the tap circuits. The main feeders are always the easiest to calculate. Taking, for instance, the feeders of Fig. 1, that feeding cabinet *A* carries the current of fifty-one 110-volt lights one hundred feet. Assuming the maximum variation of pressure to be five volts from bus-bars to lamps, we may allow two volts loss in these feeders, which leaves three volts for the taps and sub-feeders. The line loss is 2, the lamp-feet 5,100, and, applying the formula for 110 volts, $R = \frac{E}{NF}$, we have $\frac{2}{5,100} = .00039$ ohm per foot of wire, which is equivalent to No. 6 B. & S. wire, this being just a little large. If it were decided to have three volts drop on this feeder, No. 8 B. & S. would be the nearest size, it also being a little small. In this case it would be better to use the No. 6 wire, for it is always preferable to have the mains large rather than the sub-wiring, as the latter can be more easily changed if at any time it is desirable to increase the lights on the sub-circuits. Also, it is cheaper to scrap small wire than large. The little chandelier (circuit 2) carrying four lamps 20 feet away from the cabinet involves but 80 lamp-feet, and the volts lost must be three in order that the loss be uniform from bus-bar to lamp socket in every case; applying the rule,

the resistance per foot will be $\frac{3}{80} = .0375$. This is much higher than the resistance of No. 14 wire, but nevertheless we must use No. 14, because the insurance code permits no smaller. The lights on this chandelier will, therefore, burn above candle power. Circuit 3, which feeds cabinet *C*, figures out 1,690 lamp-feet. The line loss must be less than three volts, for we must have something for the inevitable loss in circuits 7 and 8, as we cannot make these wires of no resistance. Let the volts lost in circuit 3, therefore, be 2, and the resistance in ohms per foot is $\frac{2}{1,690} = .0011$ — most nearly No. 10 B & S. If we allow .75 volt for the circuits 7 and 8, the wires will be No. 14 on the fifty-foot circuit and No. 12 on the seventy-foot circuit respectively. The taps feeding the lamps are so short and carry so few lamps that it is probable that the wire would figure out nearer No. 20 than anything permissible. As before stated, No. 14 would have to be used, the drop through which would be negligible; but in all probability the contacts in the rosettes and sockets would absorb .25 volt so nearly that the lamp voltage would be within that amount of the rating."

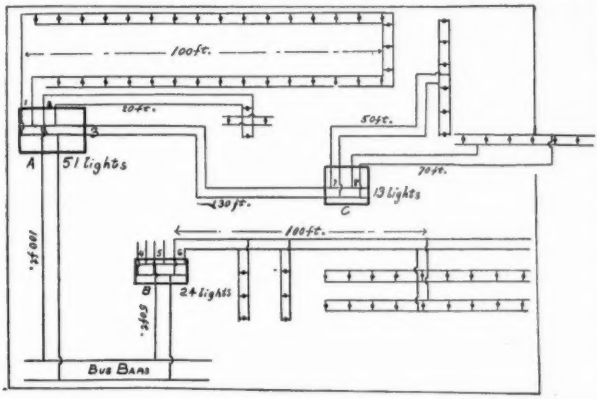


FIG 1.

In selecting wires, it is necessary to compromise between those much too large and those too small, but, in making such approximations, we should endeavor "to compensate . . . for enforced errors"; thus, if the mains must be larger than calculated, the subfeeders may be somewhat smaller. If, in the circuit marked 1 in Fig. 1, "we were to calculate the wire . . . with scrupulous accuracy, we would find that the wire between every lamp would be of a different size. This would be a difficult circuit to run, and would involve many joints."

This would be carrying accuracy to an uneconomical point. Practically, one size of wire would be used for all of these leads. Where, on one side of the circuit, the wire is too small, this error will be balanced approximately by the too large wire on the other side. Assuming the lamps to be "bunched together at a distance from the source of supply equal to one-half the

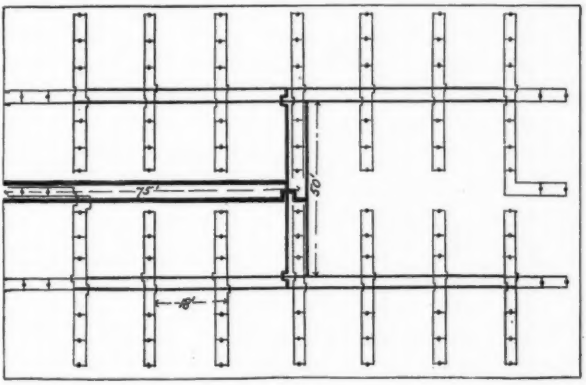


FIG. 2.

length of the circuit, the lamp-feet of the bunch may be found by multiplying this distance by the number of lamps. In the case under consideration "the distance is 100 feet, and, as there are 34 lamps, we obtain 3,400 lamp-feet. With three volts drop, the wire would have a resistance of .00088 ohm per foot, the nearest size being No. 9 B & S."

This style of wiring, called the "loop-

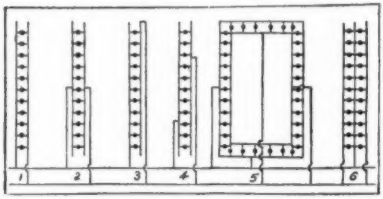


FIG 3.

circuit," is a favorite method; but such circuits, when they comprise many lamps and long distances, "call for a wire so large that it cannot conveniently fit in the lamp rosettes and fixtures."

Six examples of tap-circuits are shown in Fig. 3, and are explained as follows:

"No. 1 is the ordinary tap circuit fed at one end. Unless it is very short and has but few lights, the last lamp will burn at a noticeably less brilliancy than the first one. No. 2 differs from No. 1 in that it is fed in the middle. By this means the lamp at the end is not so far removed from the source of supply, and such a circuit could be twice as long as one of the No. 1 type without affecting the relative brilliancy of the lamps it feeds in any greater degree. No. 3 is the loop-circuit already described, and gives better distribution than No. 2. No. 4 gives even better distribution than No. 3, but is not as convenient, for it uses two single-pole branch blocks instead of one double pole block. No. 5 is a method sometimes used on large rectangular chandeliers, rows of border lights, and in similar cases. It is not used often, for the numerous feeders must be brought to one point, in order that the circuit may have appropriate switch control. A loop-circuit would almost always be better. No. 6 is illustrative of a system which is adapted to either the three- or two-wire system; it is very important, for many plants are wired on this system, so that they can operate on the two-wire system with their own power, and, in case of a breakdown, the three-wire mains of the local lighting company could be called into play by the mere throw of a switch. It is obvious that this circuit can be fed in the same ways as 2, 3, 4, and 5, as may be desired."

To calculate an electric circuit: (1) Divide the circuit into sections of equal current carrying requirement as nearly as possible. (2) Calculate the lamp-feet of each section credited with the lamps on the tap circuits as well as with those it feeds directly. (3) "Choose a line loss. By carefully choosing this you may avoid odd sizes which are inconvenient and not largely kept in stock. Remember that the line losses by any path from switchboard to lamp socket should, theoretically, sum up to the same predetermined amount." (4) Calculate resistance, as above explained, and select the wire in accordance with suggestions previously made, but avoiding selection of wire smaller than is permitted by insurance rules.

It will be seen that the exercise of judgment is necessary all through the work. "The line-loss, lamp-feet rule applies only to cases where both wires of the circuit are considered."

Reduction of Speed in Electrical Machinery.

THE tendency toward lower speeds with dynamos is likely to run into extremes before it stops. Most fads pass reasonable limits before the absurdity of extremes impresses the average mind. It would be well if some one interested in this subject would compile authentic data from which some intelligent comparison of the respective durability of high-speed and low-speed dynamos could be made. In an article in *The Electrical World* (June 20) Mr. William Baxter intimates a belief that electrical engineers are already going too far in this direction, and gives some very good reasons for this opinion. He cites instances —not few—of high-speed dynamos that have run fifteen years and are still serviceable, and says that, while "many of these

machines have solid bearings, . . . the original bushings" of some of them are "still in use." It is true that often the commutators on these machines have been several times replaced; but, since the introduction of carbon brushes, the wear in this respect has been greatly reduced, and there appears now no good reason why, with machines properly adjusted to prevent sparking, the wear of commutators should be excessive as compared with other parts. Comparing what are "considered high-speed dynamos" with dynamos connected directly to steam turbines, the speed of the former is very low, yet the wear on the steam turbine dynamos is not found excessive.

Electrical machines are simple. Practically they have but one moving part, and the motion of this part is the easiest possible to any mass,—rotation on a central axis. Nice balancing is, of course, essential, but, as this is a matter always carefully attended to by first-class manufacturers, Mr. Baxter sees no reason why a speed of "seven hundred revolutions per minute should bring any undue strain on a 100 k w generator designed for a speed of two hundred and fifty revolutions, if directly connected." This seems sound judgment as applied to the speed of dynamos. On the other hand, the reduction of speed in motors has been advantageous. Fourteen hundred revolutions for one horse-power motors, and twelve hundred for five horse-power motors, are recommended. It is not, however, the avoidance of injury to the motor, but the avoidance of complications for reducing the speed between the motor and the machinery which it is employed to drive, that is the main consideration in favor of lower speeds for motors.

Uses of Asbestos in Electrical Appliances.

AN unusually interesting article on asbestos, by Mr. George Heli Guy, appeared in *The Electrical Engineer* (June 10). Mr. Guy describes the sources and methods of obtaining asbestos, and the processes it undergoes in the manufacture of the numerous articles for which it supplies all or a part of the material. Its applications are constantly increasing, and are well set forth in the article named, but the uses it finds in electrical appliances as given in this abstract are the only ones which find an appropriate place in this department.

"A form of asbestos very familiar to the electrical engineer is vulcabeston, which is composed principally of asbestos and rubber vulcanized. It is exceedingly tough and strong, dense, non-absorbent, and highly resistant to heat. It possesses great mechanical resistance to blows and pressure, and is readily manufactured in the forms most useful for electrical purposes. Vulcabeston is one of the standard materials for the insulation of dynamos, motors, arc lamps, converters, street-car controllers, switches, rheostats, thermostats, and many other forms of electrical apparatus. It is invaluable for the insulation of magnet spools, bushings, washers, commutator rings and sleeves, and controller parts, and for the covering of armatures.

"The newest departure in the asbestos field is the construction of electrothermic apparatus. The heating effect of thee lectric current is utilized by embedding the wire in an asbestos sheet or pad. The pad is used by physicians and nurses for maintaining artificial heat in local applications, and is said to be already largely used in hospitals. Another application of the same principle is to car-heaters. A sheet of asbestos, with the embedded wires, is clamped between two thin steel plates, and the portable heater thus provided, or a series if need be, is connected to the car circuit quickly and easily. It gives an even and healthy heat, and can be so regulated as not to overheat the car."

Doubtless new uses for this material in the electrical industries will yet be found, since in other kinds of work its applications are constantly increasing in number.

The New York Custom House 220-Volt Plant.

THE feasibility of the employment of the 220 volt current for electric lighting in isolated plants has been satisfactorily demonstrated in the lighting and power

plant of the New York custom house. All doubts of the advantages secured by this pressure in a combined light and power installment seem to have been set at rest by the operation of this, the first isolated plant of the kind installed in the eastern part of the United States. A brief, though very good, illustrated description of the plant is presented in *The Electrical World* for July. The light units and power units being each run at 220 volts, these units are equally adapted to supply either light or power, as occasion may demand, which innovation, we believe, is peculiar to this plant. Of the three units, two are used for lighting and the other for power, and it is immaterial which one is temporarily or permanently used for the power-supply. The light and power may at any time be taken from one and the same circuit, this having been arranged for, but not yet done.

The generating plant, according to our contemporary above named, has 6 generators, each of 75-kw. capacity, at 250 volts, running at a speed of 275 revolutions per minute. These machines are direct-connected to three 120-h. p., Harrisburg Ideal, self-oiling, automatic cut-off engines. The dynamos are of the ironclad type, designed especially for isolated lighting installations. The advantage possessed by this class of machine results from the use of a magnetic field circuit of cast steel of high permeability. Currents of air constantly circulate through the armature and the windings, thus affording satisfactory ventilation and a consequent reduction of heat. The armature is of the drum type, the conductors consisting of separately-insulated bars, embedded in slots on the armature core. The commutator is connected to the armature winding by flexible connections, obviating all danger from expansion and contraction of leads. Carbon brushes are used on these machines, and a new form of brush-holder provides means for carrying away the current from the carbon brushes with the least loss. The improvement consists in plugging into each brush one end of a short length of flexible conductor, the other end being placed in firm contact with the holder. This gives a connection of least resistance between brushes and holder, and at the same time gives a freedom of action to the brushes that is not obtainable by the ordinary methods. The brush-holder yokes are supported by the outboard bearings. The smoothness of action of these combination units and the freedom of vibration are remarkable, and it would be difficult at almost any time, with one's back turned, to tell whether they were in motion or not. The engines maintain a very constant speed, thus insuring a steady light.

The steam-generating plant is said to have presented some unusual difficulties, owing to irregularities of the space in which the boilers had to be set. All of these difficulties, however, were satisfactorily surmounted, and two batteries of two horizontal tubular boilers with Hawley down-draft furnaces were supplied by the Harrisburg Foundry and Machine Works. The switchboard—of Tennessee marble, without frame, but supported upon pedestals—has twelve double-pole circuit switches, three double throw, three-pole dynamo switches, three voltage regulators, three Keystone ammeters, two Keystone voltmeters, and one Keystone ground detector. Each of the double-throw switches is connected on one side with the power bus-bars, and on the other with the lighting bus-bars.

As there appears to be at present a strong leaning toward 220-volt incandescent lamps, the success of this installment is a matter of much interest to electricians, as an important departure in practice.

The Third-Rail System for Tramways.

THE trial of the third-rail system at Nantasket Beach seems to have proved its engineering practicability for car-propulsion, but it leaves the commercial practicability yet an open question. As a means of propelling cars in cities, it has obviously much to recommend it. The unsightly and, it must be confessed, sometimes dangerous overhead trolley wires, which are the plague of fire departments, may thus be obviated to the improvement of streets

and gratification of the public. As only the length of rail under the car is alive at any time, it would seem that the system is less dangerous than trolley wires; but the danger of running down people in the streets will remain, this being a matter independent of the mode of transmitting power to the car motors, and related strictly to speed of running, efficiency of brakes, and systems of management.

The genius has not yet arisen who can point out the way whereby the speed now allowed in many places can be maintained with immunity from danger to foot-passengers in much-frequented streets, the causes of which the people in part contribute through their personal negligence and carelessness. Brief abstraction of mind or inadvertence may yet leave time for recovery when street-cars run at the rate that formerly prevailed with horse-cars; but, when eight and, in some instances, twelve miles an hour are permitted, the liability to such accidents is increased in a ratio much larger than that of the increase of speed. The mechanical power required to stop a car by its brakes increases as the square of the velocity. The ability to think and act quickly in an emergency appears, with most people, to vary inversely with the precipitancy of the occasion, and this holds good both for motormen and those in danger of being run down. Hence even a small increase in speed of running increases the element of risk considerably.

But the third-rail system does not add anything to this danger by reason of its intrinsic character, and on its merits it will, we think, attract the attention of railroad men, its commercial success depending upon the relative first cost and its current cost for propulsion and maintenance.

Interior Lighting.

A WRITER in *Electrical Plant*, starting from the assertion that, unlike exterior lighting, interior lighting, on account of the complexity of conditions, is not amenable to mathematical computation, holds that there are two main requirements, which every one dealing with lighting questions should aim to secure. In the first place a certain intensity of illumination should be fixed upon as necessary to the convenient performance of the particular occupation or occupations commonly carried on in the room in question. Obviously, a greater intensity of illumination is necessary in some rooms than in others, as in places where very fine work, requiring a great deal of light, is performed; but, generally speaking, rooms for lighting purposes may be divided into three classes—viz., dwelling-rooms, workshops, and offices, for each of which a special intensity of illumination is desirable.

In the second place, a uniformity of illumination should be aimed at, and in those cases where only a good effect is required, and where work requiring high intensity of illumination is not carried on, the question of uniformity of illumination is the most important one for consideration. If the different points of light are so distributed that there is no one spot which looks darker than another, even if the absolute illumination is of a low grade, the room in question will have the appearance of being brilliantly lighted.

The author holds, also, that, in large rooms the ordinary method of fixing small units of light, at equal distances from each other, upon the ceiling is faulty, that uniform distribution is not thus secured, and that to approximate to uniformity of illumination the lamps must be concentrated towards the outer boundary of the area to be illuminated.

If instead of using five hundred 16-c.p. lamps distributed at equal distances throughout the area to be illuminated, twenty-five groups, of twenty 16-c.p. lamps, are arranged at equal distances throughout the area, the light at the central point is in the case of the grouped lamps less than in the first case; the fewer the sources the less the total illumination at the center, and although the points near the centers of the lamps will be much more strongly illuminated than corresponding points near the single lamps, the intensity at any point of minimum illumination will be less. The total candle-power will, however, require to be greater with few than with many lights.

THE ENGINEERING INDEX—1396.

Current Leading Articles on Applied Electricity in the American, English and British Colonial Electrical and Engineering Journals—See Introductory.

Lighting.

7034. Meters. Jas. Milne (Touches on some of the more important meters in practice, making comparison with some of these meters from actual results). Can Elec News–July. 7500 w.

7073. The Electric Lighting of the Metropolitan Life Insurance Company's Building, New York (Description, with illustrations, of one of the finest plants in the city). Elec Eng–July 15. 1600 w.

7081. The 220-Volt Light and Power Plant at the New York Custom House (An illustrated description of the first and only plant in the east using this pressure). Elec Wld–July 18. 1500 w.

*7118. Arc Lighting from Alternating Current Lighting Stations. Frank Lewis (Brief discussion of the subject, making comparison with continuous current lamps). Elec Rev, Lond–July 3 1100 w.

7185. Alternating Current Machinery at the Buda-Pest Millennium Exhibition. Alfred O. Dubsky (Illustrated description. The first part describes the single-phase current machinery). Elec Eng–July 22. Serial. 1st part. 1800 w.

7317. The Detroit Municipal Lighting Plant (Description, with an account of the first year's financial operation). Elec Eng–July 29. 1800 w.

†7443. Recent Developments in Vacuum Tube Lighting. Ill. D. McFarlan Moore (Presented at meeting of Am Inst of Elec Engs., N. Y., with discussion. The object of the paper is not only to call attention to the advantages of vacuum tube lighting, but more particularly to a simple method of obtaining a current which will ultimately make such an adoption possible). Trans Am Inst of Elec Engs–March. 15800 w.

*7528. Electric Lighting in Belfast. Victor A. H. McCowen (Description of the system). Ind & Ir–July 31. Serial. 1st part. 5000 w.

Power.

6995. Electrical Equipment of Aluminum Works at Niagara Falls. Orrin E. Dunlap (Illustrated description). W Elec–July 11. 1800 w.

7033. Power Transmission by Polyphase E. M. F.'s. George White Fraser (Showing how polyphase currents have revolutionized the art of electrical generation, transmission, and utilization of power. Traces the progress of electrical working from direct current, through simple alternating, up to polyphase alternating, considers the complications that arise, the practical questions, and shows that varying conditions require the study of each case). Can Elec News–July. 4500 w.

7066. Electrical Transmission of Power in California. W. F. C. Hassen (Illustrated description of plant in Nevada County, with brief account of causes that led to its installation). Am Elect'n–July. 1000 w.

7068. How Is Motion Given to the Armature of a Direct Current Motor? Townsend Wolcott (The action of motors is explained and questions relating to it are discussed). Am Elect'n–July. 1800 w.

7069 Modern Commutator Construction (Illustrated description of various types). Am Elect'n–July. 2200 w.

7071. Faults in Dynamos (Difficulties that occur with dynamos that cause them to become inoperative, but are more properly classified as blunders rather than faults). Am Elect'n–July. 2000 w.

7074. Tests on Large Polyphase Transformers. Desire Korda (Experimental results obtained by writer). Elec Eng–July 15. 1400 w.

7080. On a Winding for Motor Generators. P. M. Heldt (Describes a winding combining the advantages of the windings for both continuous and alternating currents). Elec Wld–July 18. 800 w.

7083. The General Electric Series-Parallel Controller for Four-Motor Equipments. William Baxter, Jr. (A description of the action of the controller switch and the commutating switch, with diagram of car wiring and controller constructions). Elec Wld–July 18. 3000 w.

*7087. Electric Transmission of Power in Mines (Illustrations from photographs taken in underground workings, showing applications made by Messrs. Siemens & Halske, of electrical energy to the driving of mine plant, and observations founded on a communication by Ingenieur C. Köttgen). Eng, Lond–July 3. 1800 w.

*7125. Accumulator Accessories (Dealing with the accessories which are necessary for successful accumulator working). Elec, Lond–July 3. Serial. 1st part. 1000 w.

*7132. Combined Light and Power Plants (Ways in which a combination may be effected. First part describes and illustrates the Hamburg plant). Engng–July 10. Serial. 1st part. 1700 w.

*7141. Alternate Current Transformers. J. A. Fleming (Cantor lecture delivered Jan. 20, 1896. Explains the action of the transformer. To be followed by other lectures on the construction, testing and employment). Jour Soc of Arts–July 10. 6000 w.

*7162. Some Notes on Rope Driving (The use of ropes in dynamo driving, the dangers, matters that require consideration, etc). Elec Rev, Lond–July 10. 3500 w.

7177. A Mexican Transmission Plant. George J. Henry, Jr. (Illustrated description of a plant being erected in the state of Hidalgo in Mexico, to supply power to the mines of the Rio del Monte Co. One of the most remarkable installations so far made in any part of the world). Jour of Elec–May. 800 w.

We supply copies of these articles. See introductory.

7195. The Pittsfield Electric Company (Illustrated description of boiler plant, etc). Elec Wld–July 25. 800 w.

7228. The Progress Made in the Generation of Electric Energy and Its Application to the Operation of Motors During the Past Fifty Years (Illustrated review showing progress and extent of electrical industries). Sci Am–July 25. 3600 w.

*7249. On the Dissipation of Energy Caused by the Armature Currents in Electrical Machinery. Otto T. Blathy (Announcement of the discovery of an apparent new source of energy loss in dynamo armatures). Elect'n–July 17.

*7296. On the Transmission of Power by Alternate Currents. J. T. Morris (Read before the Engng. Soc., Univ. College, London. A few of the leading principles involved in the design of such power transmissions, and a few of the results arrived at in recent practice). Engng–July 17. Serial. 1st part. 1400 w.

7306. Electricity in Paper Making at Niagara Falls. Orrin E Dunlap (Illustrated description of the plant of the Cliff Paper Co. of Niagara Falls). W Elec–July 25. 900 w.

7320. Test of An Otis Electric Elevator with Leonard Motor Control System. W. H. MacGregor and R. T. Kingsford (Test of an elevator in the Fahys building, Maiden Lane, New York, undertaken as a graduation thesis, with the only object to arrive at facts). Elec Eng–July 29. 700 w.

7321. Combined Electric Lighting and Traction Plants. John Hesketh and John H. Rider (Read before the Munic. Elec. Assn., England. In proof that a combined station is the right thing, though opinions may differ as to which system the combination should be carried out upon). Elec Rev–July 29. 2000 w.

7353. The Advantages of the Multipolar Type of Electric Machinery. William Baxter, Jr. (Showing the advantages to be numerous and the disadvantages of a doubtful character). Am Mach–July 30. Serial. 1st part. 900 w.

7398. The Fidelity Mutual Life Building (Illustrated description of the power plant of one of Philadelphia's largest office buildings). Elec Wld–Aug. 1. 1100 w.

7405. Power for Machine Tools. Leland L. Summers (Problems connected with the application of electric motors to the driving of individual machine tools; results of tests, experiments, &c). Elec Engng–Aug. 1300 w.

7427. How to Avoid Fly Wheel Accidents in Power Stations of Electric Railways. William Baxter, Jr. (Describes a simple magnetic cut-out, which, if connected with the circuits as explained, will render it impossible for a generator to act as a motor. Illustrated). Power–Aug. 2500 w.

*7441. The Dissipation of Energy Caused by the Armature Currents in Electrical Machinery (Editorial correspondence criticising paper by Otto T. Blathey). Elect'n–July 24. 1200 w.

7450. The Transmission of Electric Power from Niagara Falls to Buffalo (A transmission line of unusual importance to be ready for use in November). Elec Rev–Aug 5. 1100 w.

7451. Electricity in Mining. F. B. Phelps (A review of the growth of the use of electricity in the mining industry). Elec Rev–Aug 5. 1300 w.

7491. Rope-Driving Arrangements. W. H. Booth (An examination of reasons for a statement made in a paper discussing rope-driving as applied to electrical work, with suggestions of a better design). Am Mach–Aug 6. 1800 w.

7492. Electrical Tests of Power Required by Wood-Working Machinery at the Navy Yard, Washington, D. C. Reported by O. G. Dodge (Tests of circular rip saws, band saws, planers, boring machines, etc). Am Mach–Aug 6. 800 w.

7519. Zufikon-Bremgarten Three-phase Power Transmission in Switzerland (Illustrated description of hydraulic and electrical plant). W Elec–Aug 8. 800 w.

*7532. Electrical Factories and their Machinery (The first part describes the workshops of Messrs. T. Parker, Limited, of Wolverhampton, with illustrations). Elec Rev–July 31. Serial. 1st part. 1800 w.

7543. Electricity in Private Houses. Theodore Waters (Describes the use of electric elevators in private houses, and the arrangements for safety in operation, without the employment of attendant. Illustrates and briefly describes the fine facilities for lighting a country residence and other ingenious uses of electricity). Elec Wld–Aug 8. 1800 w.

7544. Alternating-Current Motors. Dugald C. Jackson (Read before the Northwestern Electrical Assn. Careful comparative tests of alternating-current motors, made in the laboratory of the writer by J. H. Perkins and W. H. Williams, with results and explanations). Elec Wld–Aug 8. 1600 w.

Telephony and Telegraphy.

*7116. Submarine Cables in War Time (Discusses the need of neutralizing submarine cables. and gives extract from report of the Congress of the Chamber of Commerce of the Empire, showing the necessity of adding to and amending the present cable system of the British Empire). Elec Rev, Lond–July 3. 5800 w.

*7135. Australasian Telegraphy (The British telegraph interests as affected by the Pacific cable question. Urging a reduction of the Eastern Extension Co. in its Australasian tariff). Engng–July 10. 900 w.

7187. Mr. Delany on Government Telegraphy (Abstract of argument before the United States Senate Committee, with editorial favoring the machine transmission). Elec Eng–July 17. 2300 w.

7220. The Telegraph (A review of the history, with a short biographical sketch of S. F. B. Morse). Sci Am–July 25. 2500 w.

7223. The Submarine Cable (History, with map showing the position of cables now existing, and a section of the Steamship Niagara, arranged for laying the cable of 1858). Sci Am–July 25. 1700 w.

7237. The Telephone (Illustrated historical review). Sci Am–July 25. 1200 w.

*7250. Cable Specifications and Tests. Jos. A. Jeckell (Read before the Municipal Elec. Assn., with discussion. Specifications issued by those who know what they want, and are desirous of obtaining it on the most favorable terms, are considered). Elect'n–July 17. 3000 w.

†7402. The Delany System of Machine Telegraphy (Report of the Committee on Science and the Arts, on the invention of Patrick B. Delany. Accompanied by an illustrated description of the details of the apparatus and mode of operation). Jour Fr Inst–Aug. 2300 w.

7520. The Telegraph in China. From the *San Francisco Chronicle* (Explaning the difficulties in telegraphing in the Chinese language). W Elec–Aug 8. 500 w.

*7531. The Naglo Equipment for Telephone Exchanges. Hess-Raverot-West System. Julius West (Illustrated description of this system as applied to the experimental exchange at the Berlin Industrial Exhibition). Elec Eng–July 31. Serial. 1st part. 1000 w.

Miscellany.

*6981. The Era of Extravagance in the Electrical Business. Burton E. Greene (Showing why electrical industries were so long unremunerative, and the reasons for believing them to be now on a sound business footing). Eng Mag –Aug. 3100 w.

*7043. On the Properties of a Body Having a Negative Electric Resistance. Silvanus P. Thompson (Read before the Physical Soc. Considers what are the properties of a body having a negative electric resistance, if such a body can exist, and questions the validity of the reasoning employed in a recent paper by Messrs. Frith and Rodgers). Elect'n–July 3. 3500 w.

7082. Effects of Hysteresis and Foucault Currents on Polar Diagrams. Frederick Bedell and James E. Boyd (Notes some of the effects produced by hysteresis and harmonics upon polar diagrams). Elec Wld–July 18. Serial. 1st part. 800 w.

*7126. The Latimer Clark Standard Cell. J. Warren (Discusses the details of the named type of apparatus). Elec, Lond–July 3. 1500 w.

*7160. A New Lorenz Apparatus for the Determination of Resistance in Absolute Measure (Illustrated description). Elec Rev, Lond–July 10. 1800 w.

7188. The Jacques Carbon Battery. C. J. Reed (Description of experiments performed which determine the action derived from this cell to be thermo-electric). Elec Eng–July 22. 1800 w.

7190. The Roar of Niagara (Official report on the roar of Niagara Falls at the recent Elec. Ex. in New York). Elec Rev–July 22. 1000 w.

7191. The Rights of Electrical Companies. W. Clyde Jones (The design of the paper is to outline the course of judicial decision in a manner to be of service as general knowledge to business men and engineers engaged in electrical pursuits). Elec–July 22. Serial. 1st part. 1100 w.

7194. On the Measurement of the Insulation Resistance of Continuous Current Three-Wire Systems While at Work. Edwin J. Houston, and A. E. Kennelly (It is shown (1), how the individual leakage conductances may be approximately determined by varying the working pressure on one side of the system and observing the corresponding variation of potential to ground on the other. (2) How the resistance in and up to the ground of a grounded conductor under load may be measured from the central station). Elec Wld–July 25. 1400 w.

*7251. The Capillary Electrometer in Theory and Practice. George J. Burch (The first of a series of articles giving the main results of ten years of hard work. Describes how to make a capillary electrometer; discusses the law, gives directions for producing photographic records, and describes his method of analyzing them). Elect'n–July 17. Serial. 1st part. 2200 w.

*7276. On Alternating Current-Rushes in Condensers. Bernard P. Scattergood (Investigations of a phenomenon noticed while making experiments on a high tension circuit). Elec Rev, Lond–July 17. Serial. 1st part. 2000 w.

7307. The Insurance of Electrical Plants. R. H. Pierce (Read before the Northwestern Electrical Assn. The problem of safety is the real question. If this fire hazard is small the rate of insurance should be comparatively low). W Elec–July 25. 1600 w.

7319. Lightning Arresters. W. R. Garton (Abstract of a paper read before the Northwestern Elec. Assn. The principle is explained, and the forms that have been considered standard, with reference to difficulties). Elec Eng–July 29. 1100 w.

7322. The Organic Membranes as Insulators. Benjamin Ward Richardson (Physiological observations are described in detail and conclusions given. Also editorial comments). Elec Rev–July 29. 1800 w.

*7360. The Electrical and General Engineering College and School of Science, Earl's Court, London. S. W. (Illustrated description). Elec, Lond–July 17. 2000 w.

7390. Nikola Tesla at Niagara Falls. Orrin E. Dunlap (Account of Tesla's first visit to the plant of Niagara Falls Power Co, with his impressions). W Elec–Aug. 1. 1300 w.

*7440. The Electromagnetic Theory of Dispersion. H. von Helmholtz (Presentation of a theory, with investigations). Elect'n–July 24. 4000 w.

7460. The Thermo-Tropic Battery and a New Method of Developing Electrical Energy. C. J. Reed (An interesting contribution pointing out an apparently new method of generating electric energy. The electric current is developed merely by the passage of heat from one conductor to another, separated by an electrolyte). Elec Eng –Aug 5. 2000 w.

*7539. An Electric Frequency Teller. Albert Campbell (Description of a simple, portable instrument devised by the writer, for the direct measurement of frequency). Elect'n–July 31. 600 w.

INDUSTRIAL SOCIOLOGY

State Ownership of Railroads.

IN discussing this subject Mr. Frank L. McVey, in *Gunton's Magazine* (July), frankly admits at the outset that "the State has stability, permanence, and the power to secure unity, more than any other agency within its jurisdiction." These are advantages not possessed by persons or corporations, but they are attended by still greater disadvantages, which Mr. McVey proceeds to discuss.

"If a government insists in managing the railroads, there are only two ways in which it can be done; either the State must own the roads and lease them to private companies, or it must own the roads and manage the traffic itself. In the first case the lessee would be responsible for very little, and free, after having sold the lines to the government, to make a profit without the risk and responsibility which owning them would involve. On the other hand, unity of management—the very thing for which government ownership is urged—would be missing. Such a plan would involve the disadvantages of both private and public ownership. Upon the whole, then, we are justified in dismissing this scheme and taking up the more feasible one,—that of owning and managing by the government. The advantages to be derived from such management are stated as follows: (1) the worst existing abuses of personal discrimination and sudden fluctuation of rates would be avoided; (2) the public business would be carried on for the public good, and no one would be given an advantage over another; (3) there would result a harmonious unity of system and management not now possible; (4) State and national politics and legislation would be relieved of the corrupting influences of the railroad; (5) there would be a saving to the whole country in the lower rates and better management of the roads by the government."

These are all the desirable results claimed for State ownership, and, if the fourth and fifth of them could be established as certain to follow, Mr. McVey evidently thinks that the case for paternalism would be made out. But neither in history or in the nature of things can be found any warrant for the belief that, under State ownership, railroad management would be relieved of political corruption, or be more economically conducted than it is at present. On the contrary, the history of experiments in State ownership compel the candid student to the exactly opposite belief.

Mr. McVey shows that the low passenger rates in Europe, which advocates of State ownership are fond of quoting, are possible because less service is rendered than in the United States, where higher fares are paid; and, further, that the amount of service is least in the countries where fares are lowest. Thus, in the United States in 1893, where 2.12 cents per mile is the average fare, "one train was run 10 miles for every man, woman, and child in the country"; in England, where the average fare is 2 cents per mile, one train was run only 7½ miles for each unit of population; in France (fare 1.325 cents per mile) the service is 7½ miles per unit of population; and so on, every country in which lower rates of fare prevail giving less service than any other where passenger rates are higher. The lesson this teaches is the correlation of rates of fare with train service rendered,—a law that can no more be evaded by State ownership than the law of gravity could be evaded by the enactment that the accelerative force of gravity should hereafter be more or less than what nature has made it. Moreover, it also shows that higher train speed is correlated with rates of fare, average higher speeds going with average higher rates, so that not only quantity, but quality, of service must necessarily be lowered with diminution of average passenger rates; and this quality of service extends not only to speed, but to all the

equipment upon which the safety and comfort of passengers depend.

Losses of revenue to the State, cities, towns, and townships; the transfer of losses from private stockholders to the government; and the disabilities resulting from the fact that the State cannot be sued,—are other reasons cited by the author for deprecating State ownership.

The editor of *Gunton's Magazine*, in comments appended to the article, regards Mr. McVey's argument as a feeble one, and states severer objections.

"To buy the railways is a capitalistic investment three times greater than the subjugation of the rebellion, since it would require the government to incur debt to the whole value of the railways,—say, ten thousand millions of dollars.

"This sum, being three times as large as was the debt involved in the subjugation of the rebellion, which itself was large enough to send gold to a premium of 180, and to make our bonds worth only 40 cents on the dollar, would wholly extinguish, as the rebellion did until after the war ended, our power to borrow abroad. As we had to fight the war wholly with our own resources, we would have to buy the railways wholly with the resources of the American people. In short, the purchase by the government would consist in asking the very people who now own the railways—the Vanderbilts, Goulds, Sages, the Astors, Rhinelanders, Hearsts, Stanfords, Huntingtons, and Carnegies—to take the bonds of the government in such sum as would make it seem profitable to them to part with the railways. Who that has ever run in debt and felt the force of the maxim, 'the borrower is servant to the lender,' does not know that these capitalists, having loaned the government the means (credit) with which to buy the railways, would thenceforth own the railways as creditors more effectually than they had ever owned them as shareholders, for the government would need their skill and could only get it on their terms? Never has an aristocracy of barons been clothed with powers equal to those which these government magnates, selected from among the railway class, but dependent on federal appointment, would surely exert."

The same reasons exist for government ownership of any and all other large industries as are urged for State ownership of railways, and the system, once commenced, would inevitably be thus extended. The losses in railway investments that have been and are now borne by individuals would have to be made up by taxation or repudiation. "Either would be ruin and chaos to the government and to its creditors." The annual interest on a debt of $10,000,000,000 would exceed in magnitude any loan in a single transaction that could be made by any existing government. The present army of government employees would be reinforced by 800,000, increasing the present difficulties of the civil service four-fold, and bringing up the standing army of civilians in government employ to one million men.

"The scheme in its magnitude falls, like the project of the deportation of the African race, because its details involve it in a vastness which renders it unmeasurable and unthinkable. It is beyond the purview of intelligent reasoning mensuration, and is to be classed with such projects as draining the Gulf of Mexico and leveling the Alleghany mountains. It is quixotic, chaotic, and chimerical. It is not merely true that the event would be disastrous, but the attempt to enter upon the transaction, even on the part of a lunatic, could not occur in a lucid interval."

The Reversal of Malthus.

IN *The American Journal of Sociology* for July Mr. Albion W. Tourgee begins a paper under the above title by an allusion to the great fall in the prices of agricultural products, not alone in the United States, but also in England, France, Germany, and Spain, and to the collateral fact that, while the public domain in the United States is nearing the point of exhaustion, "farming lands have become more and more unsalable." He mentions ex-Senator Ingalls as an example of a large number of economists who appear to think that this depression in prices is, in some dimly-perceived manner, wholly cor-

related "with the financial system that has developed in the last twenty years. Those who think this correlation exists (and they far out-number those who attribute the depression to other causes) seek either in a protective tariff or in currency reform "a restorative for all the ills with which the social body is now afflicted." While Mr. Tourgee readily admits that the financial system is a cause of some potency, he yet finds other causes, which are the outcome of social, industrial, and economic relations, and which are universal.

"The steady and remarkable decline in the value of farm lands in the United States offers the first and most reliable suggestion of a cause which cannot possibly be the result either of revenue legislation or financial methods. Farm products are the necessaries of life. Their consumption, in the main, varies with the number of consumers. It does not depend to any great degree upon their social or pecuniary conditions. There is no general lack of food, clothing, or sufficient shelter in any part of the world. Everywhere there is enough, and almost everywhere a visible surplus. The only deficiency is on the part of those who have not the means of obtaining their share of the general abundance. In other words, there is no lack of supply, but only of individual power to obtain a share of this supply. Even this element is not important enough to constitute any great factor in economic speculation. If all the people in the world who are known or supposed not to have enough and proper food, clothing, or shelter were fully supplied with these necessaries, there would hardly be an appreciable diminution of the existing store.

"As a consequence, we are facing for the first time in the world's history this condition: the world is able to produce, and actually does produce, more food than is needed to meet the requirements of the population of the globe. More wheat, corn, rice, meat, and other staple food-products are raised every year than can possibly be consumed. One-fourth of the arable lands of the United States might be abandoned, and the world still have enough. The immediate issue of this condition is the fall in prices of farm products, and a necessary result of this fall in the price of farm products is a declension in farm values."

The theory of Malthus, which has been widely accepted by economists, appears to Mr. Tourgee to be refuted by existing facts. The Malthusian proposition is, in substance, that, while population approximately increases in a geometrical ratio, agricultural production increases only (approximately) in an arithmetical ratio; or, at least, whether these ratios be considered as wide of the truth or not, population increases faster than the earth's capacity to supply the wants of life, and hence, the time must sooner or later arrive when, without some limit to increase of population, the world must become over populated. This is to say that excess of population beyond the capacity to supply the necessities of life is over-population.

"To-day we are facing a situation which seems to be an exact converse of the premises on which this hypothesis was based,—one apparently establishing the fact that the world's labor, applied to and supplementing the natural capacity of the earth, has already produced more than enough of life's necessities to supply the actual population of the globe and, moreover, that this condition is likely to prove continuing.

"A scientific survey of the food-producing capacity of the earth, even with little, if any, enhancement of the present supply of labor, makes it evident that the present supply might be largely increased— possibly doubled—within the scope of existing lives. Startling though the thought may be, the statement depends for its verification on a few simple and universally-conceded facts. We know now that the most productive portions of the earth's surface are, as yet, practically undeveloped. It is asserted by the highest authorities that the tropical regions of Africa and South America alone could supply food sufficient for the whole world."

The increase in the productive power of land by improved fertilizers and improved farming implements, since Malthus wrote, is estimated to be at least five-fold. The

discovery of mineral oils has added to food resources large quantities of animal and vegetable oils formerly needed for lubrication of machinery and for illumination. The modern processes for preserving and storing food products have also added to the general stock a notable quantity of food that once went wholly to waste as food. Improved transportation has also added to the resources of the world much food formerly wasted where grown, because it could not profitably be taken to any market. Science and invention, the two great factors of production, were practically unknown to Malthus.

There is much to stimulate thought in Mr. Tourgee's paper. The remedies he suggests are summed up in the closing paragraph of his paper as follows:

"Protection for the home market; more intimate commercial alliance with nations whose needs are complementary in character with ours; restriction of production; the diversion of labor to fields of employment not immediately productive, and which minister to the public and personal enjoyment rather than material gain,—offer to us the natural and reasonable methods of adjusting our own industrial relations to these new inevitable conditions."

Is a Double Standard Desirable, or Possible of Maintenance?

ABLE replies to these questions were contributed to the July number of *American Magazine of Civics* by Mr. W. A. Richardson. These replies are prefaced with comments upon the inconsistencies of the attitude now assumed by the advocates of free silver coinage at the ratio of sixteen to one. Denouncing protection as wrong in principle and unjust in practice, the silver men gravely propose to protect the silver industry by compelling people to accept silver as money at nearly twice its actual commercial value. If this can be brought about, sales of silver bullion will cease in the United States, and the silver bullion wanted will be imported. But, as silver may be about doubled in value by having the government manufacture it into dollars, silver manufacturing by private establishments, which require investment of capital in stock and plant, will languish. We shall become the great dollar manufacturing nation of the globe; but the export trade in dollars will be small.

Again, the advocates of free coinage of silver at the ratio of sixteen to one maintain that they are friends, and are acting in the interests, of all those who live by mental or manual labor; yet it can be proved to a certainty that from the time the United States adopts this ratio, without the concurrence of other principal commercial nations, the wages of labor will almost immediately have less purchasing power than they have now, while any advance in wages will have to be struggled for, and the condition of labor would thus be injured, not improved.

"To most of us," says Mr. Richardson, "it is confusing to read in Walker that there is a demand for that amount of money which is required to do the money work and no more—that no more can be used; and then to read in Cernuschi and Tuck that there is an insatiable demand for money at the mint. It is confusing to read that free coinage would bring the silver dollar up to the value of the gold dollar; and then to read that it would be unjust to require the debtors to pay their obligations with the appreciated gold dollar. It is confusing to read that there is a divine relationship between gold and silver, and that in adopting the ratio of sixteen to one we but reënact a divine ordinance; and then to read that the ratio between the two metals is a mere matter of law,—that the ratio could be fixed at one to one, if all the nations would but join in doing it.

"To most of us there seems to be a contradiction between the claim that we adopted a double standard in 1792 and the claim that silver was made the standard by that law.

"It seems inconsistent to claim that the 'compensatory law' was deduced from the uniformly and universally practical working of bimetallism throughout thirty-five centuries of history, and to claim that

France alone maintained the parity of the two metals from 1803 to 1873.

"We cannot help wondering how it was that France alone, of all the countries under bimetallic laws, did all the work. We cannot help wondering how the United States committed a crime in 1873, if she had done nothing prior thereto toward keeping the two metals at a parity. We are puzzled to know why France, and France alone, is not responsible for all the evils that have come from the demonetization of silver, if she alone maintained it at a parity with gold prior to 1874,—nay, above gold in the ratio.

"The friends and advocates of bimetallism are as conflicting as the writers. One will lay the stress on the need of more money, and will plant himself firmly on the quantitative theory. One will lay the stress on the efficacy of the law, and will work himself up to a corybantic frenzy over the crime of 1873. While others will, indifferently, use the demand and supply argument or the fiat argument; will ply you with heartless figures, or poetically personify silver as a wronged goddess. We seek the truth, and, despairing of getting our confusions cleared by reading this literature, we go to history.

"For more than eight hundred years after the fall of the Roman empire the currencies of Europe, or, at least, of western Europe, rested on a silver basis." The concurrent use of gold and silver as a basis of currency failed uniformly in Florence and the other Italian republics, in the German States, in Austria, the Netherlands, Spain, England, and France, in spite of the great efforts to effect it. "All that these States succeeded in obtaining . . . was an 'alternate standard,'—now gold, now silver, but never both together." In 1798 England refused longer to mint silver, and in 1816 adopted the gold standard. The same results have followed succeeding attempts to yoke silver and gold together; only one member of the team does the pulling; like an ill-broken team, they cannot be made to draw together evenly. "First one money has been recoined, and then the other, in order to fit their weight to variations in relative value. Incessantly one of the moneys has become too heavy or too light," and, in accordance with the law of human nature, "the lighter money has driven the heavier out of circulation." Invariably it has been the worst money that circulated, wherever a double standard has existed.

The experience of the United States is no exception to the rule; neither is the modern experience of France, with its ratios of fifteen to one and sixteen to one.

It seems almost impossible for a logical mind, in reading Mr. Richardson's able historical survey of attempted and defeated bimetallism, to reject his conclusions that bimetallism is not desirable even if possible; that it is only *nominally* possible; and that it "has never existed, unless you call the present system bimetallism, which it is in fact,—the system which makes one money the standard and the other the token." The account of past efforts to establish a double standard is extremely interesting. We pass it with the remark that many of those who think they know all about the "silver question" will find their self estimate not so flattering after a careful perusal of Mr. Richardson's paper.

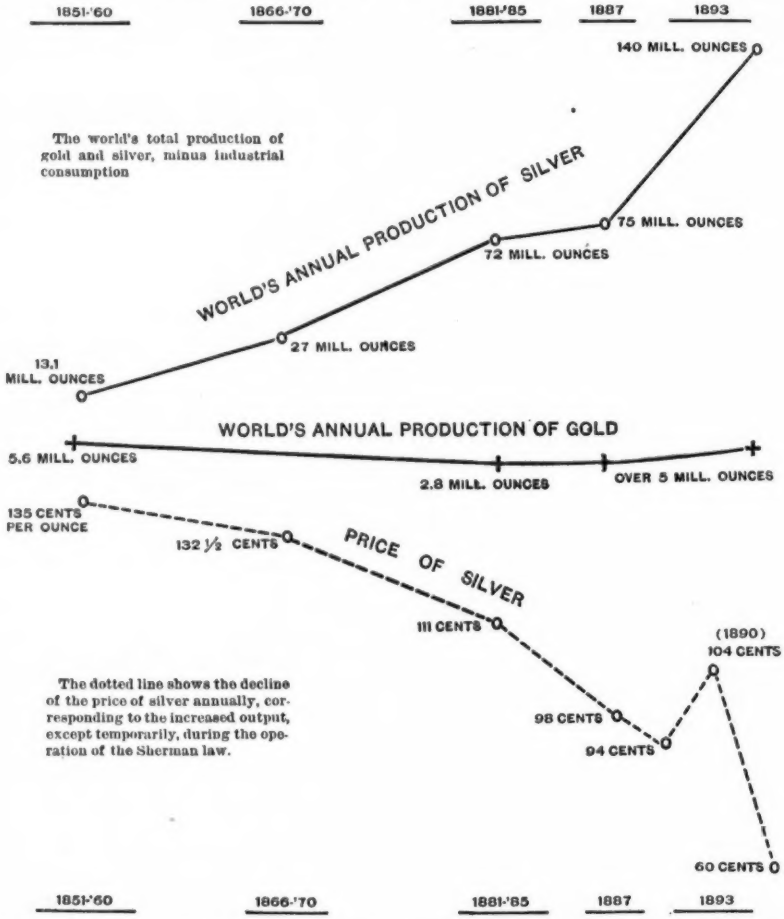
Why the Commercial Value of Silver Has Declined.

IN an able article entitled "The Silver Question," *Bradstreet's* (July 18) refutes the assertion that the discontinuance of the coinage of silver under the act of 1873 has caused the decline in the commercial price of silver. The fact is that this decline began before 1860, and has continued with the increase in production, although not precisely in the same ratio. One notable exception to this was the artificial rise in the price in 1890, as the effect of the Sherman act, when the price increased ten cents per ounce during a short period, after which it fell off even more rapidly than it had risen and has been falling ever since, with occasional slight upward tendencies.

To illustrate these facts, the article under review is accompanied by the chart herewith reproduced. The full line above that indicating gold production shows

graphically the increase in the total output of silver bullion, while the dotted line below the gold line shows the increasing decline in price. These lines show production for both gold and silver exclusive of that used in the arts.

Of the significance of this diagram it is remarked that, "if it were wheat or corn, or iron or copper, or some other widely-distributed useful commodity concerning which the tendencies of production and prices were indicated during the past forty years, it would, perhaps, be plainer to some people. In any event, we find by reference to this chart that the world's production of silver (exclusive of that used in the industrial arts) increased nearly elevenfold between 1856 and 1893, since which time the production has still further increased. It is also noticed that the world's production of gold (exclusive of that used in the industrial arts) fell off during the first two-thirds of the forty years referred to, since which time it has increased to nearly or about the same total per annum as that coined at the first date in the graphic illustration used. The striking feature of the chart is shown in



the two lines representing, respectively, the world's production of silver and the course of the price of silver. It will be noted that the tendency of the latter was, during the period named, to fall off in about the same ratio as production increased, with one noteworthy exception,—in 1890,—when, by the operation of the Sherman act, for a brief period the price of bar silver was artificially forced up. Since that time the inevitable law of supply and demand has reasserted itself, and the price has declined as the supply has continued excessive. With reference to wheat, or cotton, or corn, or iron, an illustration of this character would draw from the most obtuse the conclusion that the cause of the depression in its price was the excessive, the absolutely unparalleled increase in production the world over.

"If further reasoning were required, it would only be necessary to point out that, whereas the average annual production of silver throughout the world from 1873 to 1893 was about 78,000,000 ounces, between 1851 and 1872 it was only about 21,000,000 ounces, pointing to a total annual increased average production of silver throughout the world in the latter twenty years as compared with the former of about 57,000,000 ounces, thus indicating conclusively the failure of the monetary demand for silver to employ the total output of the world, exclusive of the demand for industrial uses. To those who have argued that the increase in the world's population would naturally demand a corresponding increase in the supply of silver for money, it is only necessary to add that, whereas the population of the more enlightened nations of the earth increased only about 28 per cent. between 1873 and 1893, the world's silver output during that period trebled."

The accuracy of this record being admitted, the logical connection between production and price of the two metals seems indisputable.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Industrial Sociology in the American, English, and British Colonial Magazines, Reviews and Engineering Journals—See Introductory.

*6978. The Relations of Finance to Industrial Success. Henry Clews (Showing the dangers of over-capitalization in industrial enterprises and the importance of periodical statements of their condition). Eng Mag–Aug. 2300 w.

*6979. The Fallacy of Municipal Ownership of Franchises. Frank M. Loomis (Showing that municipal ownership is robbery under the form of law, and that municipal control is the true solution). Eng Mag–Aug. 3300 w.

*6984. The Natural Wealth and Industrial Possibilities of Cuba. Raimundo Cabrera (Reviewing Cuba's agricultural and mineral resources, and the opportunities for investment which they offer). Eng Mag–Aug. 3900 w.

†6992. The Reversal of Malthus. Albion W. Tourgee (The prevailing depression is treated as the result, not of local, but of universal causes. Instead of population outgrowing power of the earth to support it, the Malthusian doctrine has been reversed and power of production is now in excess of the needs of population). Am Jour of Soc–July. 4500 w.

†6993. Profit-Sharing at Ivorydale. I. W. Howerth (Presents the salient features and the results of one of the most successful and impressive examples of profit-sharing in the United States—that of the Procter and Gamble Company, engaged in the manufacture of soap, candles and glycerine at Ivorydale, Ohio). Am Jour of Soc–July. 4500 w.

†6994. Sanitation and Sociology. Marion Talbot (The ground is taken that improvement in health and prolongation of life should not be the sole aims and results of sanitation, but that it falls short of its possibilities unless a notable improvement in the habits and morals of the poorer class of society is evident). Am Jour of Soc–July. 2800 w.

*7049. Is the Foreigner a Menace to the Nation? W. G. Puddefoot (An argument favoring immigration). Am Mag of Civ–July. 4500 w.

*7050. Is the Double Standard Desirable and Is It Possible to Maintain It? W. A. Richardson (A résumé of the experiences of our own and of other nations, from which it is concluded that a fixed ratio between silver and gold cannot be maintained, even by international agreement). Am Mag of Civ–July. 5500 w.

*7051. A Woman's View of the Industrial Problem. Alice L. Woodbridge (A well written paper, in which reduction of hours of labor, the abolition of child labor, and the payment of the same price for the same work to both women and men are advocated). Am Mag of Civ–July. 2500 w.

*7101. A View of the Competitive Industrial System (Able editorial review of the proceedings and addresses delivered at a recent meeting of free traders in London, when a debate upon "The Ethics of Economic Competition" was held, in which Mr. Guyot and M.

Leroy Beaulieu participated). Jour Gas Lgt–July 7. 1800 w.

7102. The Silver Question (Diagrammatic representation of the output of silver and gold from 1851 to 1893, and of the prices per ounce of these metals during the same time, with explanatory text). Bradstreet's–July 18. 1600 w.

7103. To the Farmer, the Laboring Man and the Clerk. Edward Atkinson (The effects upon the interests of the classes named, which would result from free silver of full legal tender at the ratio of sixteen parts of silver to one part of gold). Bradstreet's–July 18. 1500 w.

†7168. A Record of Industrial Progress (A summary of the industrial progress of Japan, in its relation to British and East Indian commerce, and attempt to forecast the future). Ind & East Eng–June 27. 1700 w.

7180. The Foreign Commerce of New Orleans. Worthington C. Ford (The character, extent, and probable future of trade in this port are considered, with graphic indications of exports and imports, and distribution, with statistical tables). Mfrs' Rec–July 17. 2000 w.

7213. Capital and Labor. G. P. Clapp (The author thinks the present dearth of employment should be met by the universal adoption, by all civilized nations, of an eight-hour law). Can Eng–July. 2800 w.

†7260. Values of Foreign Coins. (Tabulated statement of values of foreign coins as annually estimated in accordance with the act of March 3, 1873, by the director of the mint for the period beginning Jan. 1, 1874 to April 1, 1894). Cons Repts–July. 1500 w.

†7261. Foreign Weights and Measures (Table embraces only such weights and measures as are given in consular reports and commercial relations). Cons Repts–July. 700 w.

†7264. Nicaragua: Natural Resources and Industrial Conditions; Opportunities for United States Trade; American Interests (Rates of wages; attitude toward foreigners; needed legislation upon emigration and naturalization; climate; water, public health, etc., are topics treated). Cons Repts–July. 4300 w.

†7265. Market for United States Goods in Nicaragua. (An able essay with statistics in tabulated form upon a variety of subjects connected with the establishment and increase of trade between the United States and Nicaragua). Cons Repts–July. 8000 w.

†7266. Cost of Goods Delivered in Nicaragua (Extensive list, with prices, compiled from an inventory of one of the principal importers at San Juan del Norte). Cons Repts–July. 2500 w.

*7274. Where Do the Immigrants Go? Cyrus C. Adams (Brief explanation of the distribution of the foreign element in our population. Effect of climate, accustomed vocations, location of different nationalities, etc). Chau–Aug. 2800 w.

*7356. New Customs Tariff of Victoria (Tabulated statement of duties now leviable on articles imported into the Colony of Victoria). Bd of Tr Jour–July. Serial. 1st part. 3500 w.

*7357. Tariff Changes and Customs Regulations (Russia, Denmark, Belgium, France, Portugal, Spain, Italy, United States, Uruguay, British India, Trinidad and Tobago). Bd of Tr Jour–July. 4500 w.

†7358. Is Japanese Competition a Myth? Robert P. Porter (This writer asserts that the Japanese are already in the American market with goods that for excellence and cheapness seem for the moment to defy competition. The kinds of goods are specified and described, and their prices stated). N Am Rev–Aug. 4300 w.

†7359. Natural Bimetallism. George H. Lepper (Makes a very plausible and apparently practicable suggestion of a plan whereby, with gold yet the standard, silver may be made the basis of legal tenders that shall be and continue practically at par with gold). N Am Rev–Aug. 1600 w.

*7392. Sweating System in New York City. Julius M. Mayers (A full and interesting description of the system in all its details. How it obtains and how it pays its labor. Based on testimony given before the New York State committee, appointed in March, 1895). Gunton's Mag–Aug. 2700 w.

*7393. Labor Problem in Japan. Fusataro Takano (The era of social evolution into which the Japanese have now come, will, it is predicted, soon bring the labor question to the front in Japan. The welfare of the working people has hitherto been totally disregarded). Gunton's Mag–Aug. 1600 w.

*7394. The Basis of Real Bimetallism. John Holley Clark (The belief that government fiat can create or add to value of money is treated as based upon a superficial view of phenomena. All this government can do is to certify value by coinage, etc). Gunton's Mag–Aug. 1500 w.

7407. Free Banking, Instead of "Free Silver," as a Cure for Hard Times. Austin W. Wright (An analysis of the present financial system as contrasted with a system of free banking). Elec Engng–Aug. 5700 w.

*7412. Demarcation of Work (Editorial discussion of one of the most difficult and unpleasant features of modern labor troubles). Engng–July 24. 2000 w.

*7444. The Development of Trade With Our Colonies (The proposed federation of the British Empire is discussed, and its difficulties considered. These are regarded as making the problem to be solved one of the most knotty and perplexing ever grappled with by statesmen). Ir & Coal Trs Rev–July 24. 3600 w.

*7445. The Labor Question in an English Foundry. R. A. Hadfield (A paper read before the Foundrymen's Assn., Philadelphia. Experiences of an English firm in averting strikes, shortening hours of labor and cultivating friendly intercourse with employees). Ir & Coal Trds Rev–July 24. 2000 w.

7499. Trade With Japan. D. Allen Willey (What a representative of the Bank of Japan tells the Manufacturers' Record. Southern cotton and other products find ready market there). Mfrs Rec–Aug 7. 1400 w.

MARINE ENGINEERING

Queer Doings in the Navy.

MR. ASA M. MATTICE, late of the engineer corps, U. S. N., and now a member of a shipbuilding firm in the eastern States, has recently addressed a letter to a member of the house of representatives (Hon. Francis H. Wilson) upon the condition of affairs in the United States navy, which he and many others regard as a disgrace to the government. The letter has been printed in pamphlet form and has had a wide circulation.

Approving the provisions of the bill introduced by Mr. Wilson and by Senator Squire (H. R. 3,618, S. 735), the purpose of which is to increase the number and improve the status of the engineer officers of the navy, Mr. Mattice directs attention to the fact that "the most powerful vessel of to-day has the same number of engineers that the smallest iron-clads had in 1864, although the modern ship has over fifty times the engine power of the former. . . . Moreover, in 1864 there was not a compound engine afloat, in merchant or naval service. We have now passed through the era of the compound engine, and are in the age of the triple and quadruple expansion." Whereas forty pounds of steam was the maximum pressure in 1864, vessels in the navy now carry one hundred and sixty pounds. Twin screws have become the rule, instead of the exception, and triple screws have come into use. The multiplication of auxiliary machinery for ships has kept pace with all the other advances. The extent to which this has been carried is exemplified by the fact that, whereas "in 1864 few ships had any other than the main propelling engine and a couple of donkey pumps," the monitors having, "in addition, engines for working the turrets and for ventilating (not over a half-dozen engines in all), the Columbia has no less than ninety separate engines, having one hundred and seventy-two steam cylinders." The author next asks the significant question:

"Why is it that, with the departure of the old-time frigate and the advent of the modern steam fighting-machine, we have fewer engineer officers and more sailor officers, both in actual and relative numbers? Why is the number of engineers decreased in tenfold inverse ratio to the increase of their duties and responsibilities? Is it not evident that there is something radically wrong about the *personnel* of the service?"

To these questions the general answer is made that "the key to the whole situation may be found in the fact that the navy is managed, practically, by a certain clique of line officers, better versed in the arts of intrigue than in their own profession, who have, by hook and by crook, so managed to gain control of affairs that they are enabled to run the navy in furtherance of their own interests rather than the interests of the country. . . . This clique is not at all representative of the majority of their corps. The many line officers who are skilled in their profession and faithful in the performance of their duties—officers of the stamp of which Decaturs, Perrys, and Farraguts are made—should not be judged by this coterie of schemers, who disgrace their cloth."

From this general charge Mr. Mattice proeeeds to particulars. The secretary of the navy, nominally at the head of naval affairs, is, practically, "next to powerless," because the "boss" of the "clique or machine has the navy as completely in his personal power as any municipality is in the power of its local boss," and manages to have nearly all communications with the secretary, "incoming or outgoing, . . . passed through the meshes of its net. The secretary must depend upon naval officers for information and advice, and for the execution of his orders; and the 'machine' sees to it that these functions are performed, as far as possible, by its own members."

Specimens of these audacious methods

follow in Mr. Mattice's strong arraignment. We pass these, and also a statement of the *personnel* of the navy, only repeating the allegation that, while there are one hundred and thirty commanding officers, there are only seventy chief engineers,—"an anomaly that appeals directly to one's common sense."

Mr. Mattice says that his class graduated from the Naval Academy in 1874, "yet there are engineers of that class who have had more sea-service than some of the commodores who graduated in 1856. Eighty-four line officers were, by the last *Navy Register*, '*on duty*' in Washington,"—"about a third more than on board all the ships of the north Atlantic fleet."

It is further charged that, in addition to direct assaults upon the engineer corps, the machine has sought by various intrigues to throw discredit upon that corps. In sustaining this charge, the author alludes to the episode in the history of the Dolphin, built at the Morgan Iron Works by the late John Roach. He gives no names, but it will be at once unmistakably inferred by all familiar with naval affairs that it is to this incident that he refers. "The then secretary of the navy (Secretary Whitney) was generally credited with attacking the results of the previous administration for political effect. We regard it as greatly to ex-Secretary Whitney's honor that the following explanation of that affair is most probably the true one.

"Those . . . who knew the true inwardness of the affair knew that the secretary was grossly deceived by his advisers, . . . who managed to gain his confidence immediately upon his appointment to office. Their ultimate purpose was to discredit the engineers of the navy (who had designed the machinery and superintended its construction) as a means of helping through a bill introduced in congress to reorganize the navy in such a way as to put the engineers more fully under the thumb of the machine. It mattered not to them that they ruined the builder of the ships as an incident of their attack upon the engineers."

But it is charged, further, that they intrigued to get English firms to establish plants in the United States, and endeavored to induce the secretary to purchase foreign machinery in preference to American. In proof of this, letters from a line officer in London to the navy department are quoted.

Instances of unjust discrimination between the engineer corps and the line officers in the imposition of penalties for dereliction of duty are recounted. These examples are flagrant, and well worth careful consideration, but we cannot quote them. We can only contrast the penalty of one year's suspension from rank and duty imposed upon an engineer for not leaving his post until relieved, when ordered to leave by the officer of the deck, in direct contravention of the articles of war, and the sentence imposed upon a lieutenant for the second offence of drunkenness on board ship, which was one year's suspension from rank and duty on "waiting orders" pay, with loss of promotion during that period, but with a recommendation of clemency appended. The other instances cited, illustrating the difference with which naval courts martial regard offences committed by engineers and officers of the line, are equally flagrant. As a result of most glaring injustice, one able and estimable chief engineer became a physical wreck, and died in an insane asylum.

This letter is, in many ways, an important document. It is well written. Its facts are well selected for revealing existing abuses, and, like an X-ray photograph, it portrays the inner frame-work, unobscured by the plausible outer covering that so often hides actual facts.

Speed of Transatlantic Vessels.

COMMENTING editorially upon the records of the more recently built transatlantic steamships, *Engineering* (July 3) notes the fact that a period when the ocean is comparatively free from ice, and the Newfoundland coast is free from fog, follows the early summer, and constitutes what it calls "the season of short runs." During this time everything is usually favorable to the making of the quickest voyages. Notwithstanding that the earlier period is not

so favorable, the fact that some of the ships made new records this year before the first of July is noted. But the opinion seems to be entertained that the struggle to exceed, or even to rival, such speeds will not be maintained in future construction. On this point it is said that attempts to excel what has now been done "would involve a large capital cost, as well as heavy running charges, and, although it might be possible to more fully utilize the ships by a shorter stay in port, as in the case of the American boats, which make four runs for every three of a Cunard liner, it is questionable if even then the margin of profit would compensate for the heavy outlay. Certain it is that the North German Lloyd, as well as the American line, have ordered ships since the advent of the *Campania* and *Lucania*, and they are content with 21 instead of 22 knots. The four new mail liners soon to be constructed by the Allan Line for the Canadian Pacific mail service will also be run at this more economical speed. The runs of the past week or two show the economy of this speed. The *Campania* made her home run last week in 5 days 12 hours 32 minutes, which is 36 minutes better than any previous passage on the long route. During this time she steamed 2,898 sea miles, so that her mean speed was 21.86 knots. Her day runs were 434, 519, 514, 510, 519, and 402, the first and last being incomplete days, while the others were of about 23 hours 10 minutes' duration. Now, the *Teutonic*, of the White Star Line, covered the same voyage in about 10 hours' more time; her actual record was 5 days 22 hours 23 minutes, during which she steamed 2,892 miles, the mean speed being 20.31 knots. The American liner *St. Paul* has also been making a record run from Southampton to New York, covering 3,113 sea miles in 6 days 7 hours 14 minutes, equal to a mean speed of 20.58. This is 2 hours 27 minutes better than the previous best run between the ports. At the same time the *Lucania* made on one day 560 miles, and the *St. Louis* 520 miles. The *Campania* made 524.8 sea miles per day of 24 hours, or 21.86 knots; the *Teutonic* 487 miles per day, or 20.31 knots; and the *St. Paul* 494 miles per day, or 20.58 knots The *Campania's* performance is magnificent; but it is, of course, largely a question of power, and it is noteworthy that for 6.2 per cent. greater speed the *Campania* has 40 per cent. more power, and consumes at least an equally larger proportion of coal. This, of course, is partly due to greater size; but the American boats carry a greater number of passengers per ton."

It is thus evident that the limit of attainable speed consistent with a satisfactory commercial profit has nearly or quite been reached, and that the speed now attained might profitably be reduced. Of course, pride has had something to do with the effort to increase speed; but commerce is generally indifferent to pride or sentiment of any kind. Profit is what is sought in business, and marine traffic cannot long be made an exception to the general rule.

English Shipbuilding.

THE extent to which the English shipyards have monopolized the shipbuilding industry is strikingly illustrated by returns published in *Lloyd's Register*. Three-fourths of all the steam tonnage (excluding vessels of one hundred tons and under) now constructed in the entire world is built in the yards of the United Kingdom. Here are some of the figures as summarized from *Lloyd's Register* in *Machinery* (London, July 15).

"At the close of the quarter which ended on the 30th of June there were in course of construction in the United Kingdom 394 vessels of 774,012 tons gross. These figures, as compared with those of the corresponding period of last year, show an increase of 67,000 tons, whilst, in comparison with the returns of the quarter ending March of the present year, the increase is 9,000 tons. It is interesting to note the marvellous revolution that has taken place within the last quarter of a century in the material of which the English commercial marine is built. Of the 394 vessels under construction in June, 313, with a gross tonnage of 741,313, were of steel; 27, with a gross tonnage of 4,026, were of iron; 2, with a gross tonnage of 150, were of wood

and composite. Clearly, the 'wooden walls of Old England' for ocean traffic will, in about half a century, be as much of a curiosity as Nelson's 'Foudroyant' or a viking's galley! In sailing vessels the disparity is not so great, the return being, of steel, 29, with a tonnage of 25,964; of iron, 1, with a tonnage of 226; of wood and composite, 22, with a tonnage of 2,333. The large majority of these vessels have been under the supervision of the surveyors of *Lloyd's Register*, in order to obtain a classification by the society, 290 ships, of 554,192 tonnage, having fulfilled the necessary conditions. Of the total number of vessels building in the United Kingdom under home orders and for sale, there are 232, with a tonnage of 396,097; and for foreigners and the colonies, 58, with a tonnage of 158,095. If we analyze the figures more closely, we find that, although the United Kingdom takes the lion's share, there is no country with a bit of coast or a port that is not a customer. Naturally, Englishmen come first, with 230 steamships. The colonies take 8, the United States 3, Brazil 7, France 2, Germany 18, Holland 3, Japan 5, and Russia 15. It may be interesting, as showing the increase in dimensions and carrying-power of the steamship of to-day, to mention that, of the vessels enumerated, 47 have a tonnage of 1,000 to 1,999 tons, 44 of 2,000 to 2,999 tons, 55 of 3,000 to 3,999 tons, 18 of 4,000 to 4,999 tons, 25 of 5,000 to 5,999 tons, 8 of 6,000 to 6,999 tons, 6 of 8,000 to 8,999 tons, whilst 1 is over 10,000 tons."

The above enumeration takes no account of twelve large warships now building in government dock-yards, or of eighty-six warships now building in private yards for the British and foreign governments.

A Great Loss.

AN exemplification of the sudden and strange mutations to which human life and all its activities are subject occurred in July. Scarcely the July 10 issue of *The Engineer*, containing an elaborate illustrated description of the greatest shipbuilding establishment in the world, had been laid upon our table, when the New York morning papers announced the nearly total destruction of the works by fire. The great industry which met with this calamity is the shipyard and works of Messrs. Harland & Wolff, Belfast, Ireland. This establishment employed just before the fire no less than 9,000 workmen and apprentices. Some statistics of output are interesting. To fully understand their significance it must be remembered that this concern not only builds the hulls, machinery, and boilers of the vessels, but also manufactures all the fittings. During the five years ending 1884 the output amounted to no fewer than forty-two ships of an aggregate tonnage of 105,625 tons, and within the three and a-half years immediately following that period the firm began, completed. and launched thirty-four vessels of a total register of 89,770 tons. During the three years ending 1890 thirty-one vessels were launched, having an aggregate tonnage of 126,175 tons. During the years 1890 to 1894 it had turned out the greatest tonnage of any concern in the United Kingdom, and was prevented from doing so in the year 1895 also only by the great strike, which delayed the launching of several vessels. Messrs. Gray, of Hartlepool, headed the list in that year. During the present year, up to date, the firm has launched about 47,000 tons of shipping. This includes the peninsular and oriental steamship China; the new vessel Canada for the Dominion line; two large cargo boats for Messrs. Bates, of Liverpool; the European for the West Indian Pacific Company; and the Conic for the Belfast Steamship Company. There is also in course of construction the Pennsylvania for the Hamburg-American line, which will be the largest cargo boat in existence, having a tonnage of 11,320 tons; length between perpendiculars, 560 feet; breadth, 62 feet; depth, 42 feet. Also several vessels for other companies.

All of the vessels of the White Star line were built in this establishment, which, since the organization of the firm, has built ocean-going vessels of an aggregate capacity of nearly one million tons. In regular course fourteen or fifteen large steamers are annually turned out of these works.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Marine Engineering in the American, English and British Colonial Marine and Engineering Journals—See Introductory.

*7008. British and Foreign Shipping Competition (The extreme probability that foreign competition will increase is noticed, the stringency of the rules restricting British owners is deprecated, and special privileges granted to foreign vessels are condemned). Engng–July 3. 2000 w.

*7010. The French Battleship "Jauréguiberry" (Describes the armament and the steam generating outfit, the latter being of special interest with reference to a recent accident which occurred therein, resulting in the death of several stokers). Engng–July 3. 800 w.

*7011. The Classification of Warships. Francis Elgar (Read before the Inst. of Naval Architects. The various systems in different countries and the difficulties attending such classification are ably discussed). Engng–July 3. 6500 w.

7047. The Engines of the St. Louis and St. Paul (Illustrated description). Sci Am–July 18. 1200 w.

*7123. The Maintenance and Repair of Marine Boilers. J. F. Walliker (Paper read before the North-east Coast Inst. of Engs. & Shipbuilders. Discusses not only the topics named in title but also design and manufacture). Prac Eng–July 10. 1800 w.

*7133. The Argentine Cruiser "Garibaldi" (Illustrated description). Engng–July 10. 400 w.

*7138. Belfast and Its Industries (Illustrated description of the port of Belfast and the shipbuilding works of Messrs. Harland & Wolff, Limited). Eng Lond–July 10. 6000 w.

7182. A Revolution in Shipping Facilities. Albert Phenis (Port Chalmette, at New Orleans, its docks, wharves, warehouses, compresser and elevator. The great work of the New Orleans and Western Railroad and its destined influence upon the commerce). Mfrs' Rec–July 17. 5500 w.

7204. A Compound Yacht Engine (Illustrated description). Am Mach–July 23. 600 w.

7218. The Transatlantic Steampship (Historical development during seventy-five years. Ill). Sci Am–July 25. 3500 w.

7231. Naval and Coast Defense (History of the development of the modern warship, with numerous illustrations). Sci Am–July 25. 3800 w.

7235. American Shipbuilding (Illustrated historical sketch). Sci Am–July 25. 2000 w.

†7267. Port of San Juan and the San Juan River (Translation of a communication published in *El Ferrocarril*, April 18, 1896). Cons Repts–July. 1700 w.

*7289. Shipbuilding—British and Foreign (Review of returns in Lloyds register, showing a more satisfactory condition in the English shipbuilding industry). Mach, Lond–July 15. 1300 w.

*7299. New Engines of the White Star Liner "Germanic" (Illustrated detailed description). Eng, Lond–July 17. 1200 w.

7347. Hydraulic Lift Dry Dock at the Union Iron Works, San Francisco (Illustrated description). Sci Am–Aug 1. 1000 w.

7361. The Lake Fleet of To-day (Review of the changes in craft employed in the lake commerce that have occurred since 1870). Sea–July 30. 900 w.

*7386. Speed Control of Modern Steamers. M. L. Wood (Extract from paper presented to the U. S. Naval Inst. Describes and illustrates a device for controlling speed and direction of the engines of a steamer directly from the bridge or pilot house instead of from the engine platform, and states advantages claimed for the method). Am Eng & R R Jour–Aug. 1900 w.

*7411. H. M. Torpedo-Boat Destroyer "Janus" (Illustrated description). Engng–July 24. 800 w.

*7430. Atlas Bronze (A description of this high tension bronze and of tests of propellers made of it, and a list of vessels whose screws are made of this alloy). Eng, Lond–July 24. 1200 w.

*7495. H. M. Torpedo-Boat Destroyer "Janus" (Illustrations and description of the engines and boilers of this vessel). Engng–July 31. 2300 w.

*7498. Unusual Corrosion of Marine Machinery. Hector Maccoll (Paper read before the Inst. of Mech. Engs. A short description of an instance where the action of corrosion was so widespread, so rapid, and so powerful as to be somewhat interesting to engineers). Engng–July 31. 1600 w.

*7500. Efficiency of Combustion and Higher Steam Pressure in Marine Boilers. J. R. Fothergill (Read at meeting of North-east Coast Inst. of Engs. and Shipbuilders, Cardiff. Discussion of the present type of boiler, and related questions). Steamship–Aug. 2800 w.

*7501. The New Steamship "Albertville" (Description of a vessel built for the line between Antwerp and the River Congo). Steamship–Aug. 1700 w.

*7517. The Manufacture of Welded Iron and Steel Pipes (Discussion of paper read before the Inst. of Engs. and Shipbuilders, in Scotland). Engs Gaz–Aug. 4000 w.

*7550. Steam Pumping Arrangements in Screw Steamers (Illustrated description). Eng, Lond–July 31. Serial. 1st part. 2300 w.

*7553. The Santa Fe, Torpedo-Boat Destroyer (Illustrated description). Eng, Lond–July 31. 1200 w.

*7554. Ventilation in Warships (Editorial discussion of much needed improvements). Eng, Lond–July 31. 1400 w.

*7556. The New Admiralty Offices (Illustrated description). Eng, Lond–July 31. 1600 w.

MECHANICAL ENGINEERING

Test Sections.

ENGINEERS throughout the world are recognizing the desirability of uniformity in tests of materials of construction. Quoting some forcible remarks of Herr Schroedter, secretary of the Society of German Iron Masters, upon the desirability of a uniform method to replace the great variety of specifications for testing now in use, Mr. P. Kreuzpointer (*Iron Age*, July 23) thinks the variety of specifications in use "indicate a variety of opinions among engineers of the properties and behavior of metals.

"In one point, however, there is uniformity of opinion,—namely, that the testing of full-sized structures or members of structures would give the most reliable insight into the quality of materials. Science demands the largest-sized test piece to satisfy her wants fully. However, economy steps in at this point, and says that this cannot be done, because it would be too expensive in labor and material to make the testing of large masses a regular practice. In our perplexity we go to consult experience for advice. And right well we did asking her opinion, for she told us that, while it is of course quite satisfactory to test full-sized material, she knew, from closely observing the properties of metals, that it is not necessary for practical purposes to go to that expense; but she was sure that a piece of metal of a suitable size, taken from the material intended to be used, would give us safe and reliable information for nearly all of our needs. If, however, experience continued, we go below that size, we get on the wrong path, and the further we depart from the proper point or source of information the more we are led astray and run the risk of accidents and injury, if not disaster. Why, do we ask, should this be so? Because, experience tells us, accommodating as metals are in very many ways,—more so than many an engineer has any idea of,—they are very set in certain characteristics, one of which is a decided objection to be interviewed and interrogated in a way that circumscribes and hinders free expression and movement. If put too much under restraint while being examined, metals are very apt, says experience, to assume a strained, unnatural position, appearing to the examiner to be something different from what they really are. The main point to be borne in mind, experience continues to explain, is that all metals are plastic, the difference of plasticity of the different metals being one only in degree, but not in kind, the softest metals being the most plastic. As a consequence, our method of testing and examining must be such as to give a metal the greatest freedom to exercise its plasticity, or else we get erroneous results. Hence the importance and necessity of reading and interpreting elastic limit, yield point, tensile strength, elongation and contraction of area, rightly and correctly, because these phenomena are functions of the plasticity of metals, and, if we obstruct plasticity, we alter those factors by which we measure the worth and value of a given metal for a given purpose. And to the degree these factors or measures of quality are altered by improper methods, to that degree our conception of the value of a metal becomes misleading."

There is a very strong flavor of practical good sense in the above quotation. Seeking for the way in which the conclusions of experience have been reached, it is found in observations of rate of flow of metals in test pieces of different shape; and rate of flow, though not the same as, is strictly correlated with the degree of plasticity; or, technically, rate of flow is a function of plasticity. Mr. Kreuzpointer believes that tests of small pieces do not give as reliable results as tests of larger specimens. On this point he says: "Suppose we measure the ductility of steel while tested in the whole plate, in a length of eight inches, and get as a result twenty

per cent. Then we cut up that plate, supposing it still intact, into pieces of various forms, widths, and lengths. On testing these pieces, we would get a greater per cent. of elongation in every piece than that obtained in the whole plate." Explaining why this can be, the author devides the process of testing into four stages: (*a*) From beginning of test till the elastic limit is reached; (*b*) passing the elastic limit to the yield point; (*c*) passing the yield point up to the point of maximum load; (*d*) the most extensive stretch from the point of maximum load to the point of rupture. It is intimated that the relations existing between these several stages vary with form and size of test pieces, and that the element of time must also be considered. "If, by short and narrow test pieces, by fillets and corners, we hinder and interfere with the free and natural movement of the particles of the metal to be tested, if the number of particles taking part in the work of resistanee is proportionally very much smaller to the load applied to tear them apart than the number of particles is in proportion to the load pulling at the full-sized beam, axle, etc., then the particles in that illy-proportioned test piece are forcibly torn apart before they have had time to stretch and slide according to their nature," and our inferences from the results are liable to be erroneous. It is therefore concluded that "the testing of a full-sized beam, plate, axle, tire, eye bar, &c., is the most satisfactory manner of testing, because of the quantity of metal in the part under stress, which quantity allows the distribution of the strains over a large area or section of the total metal, and permits each particle or crystal to take part in the work of resisting the efforts of the extraneous forces to pull the metal apart. Thus each particle has a chance to support its neighbor, the degree of plasticity or flow peculiar to the grade of metal under stress is free to exert itself, stretch takes place all over the sectional area, hence is representative of the true ductility or plasticity of the metal, and fracture finally takes place by a gradual, natural letting go by the particles of each other, by sliding past one another before final and complete separation."

Chronograph Watches.

How many people ever stop to think of the wonderful character of that mechanical marvel which nearly every one carries in his pocket? The ingenuity of pickpockets in removing these machines from the persons of their legitimate owners is, we opine, oftener made the subject of reflection than the science, invention, and mechanical skill embodied in them. A watch (rarely thought of as a machine by the average person) is, perhaps, more wonderful in all its aspects than the steamship or the locomotive. Its accuracy of movement; its durability; the slight attention required by it, though running day and night for a half century or more; its compactness; its usefulness in all departments of human activity,—are qualities which it possesses in greater degree than almost any other product of the human mind and hand.

Engineering (July 3) occupies considerable space in the illustrated description of the mechanism of the modern chronograph watch. We cannot review the technical part of this interesting article, but will simply condense some general remarks indicative of the trend of recent progress in the art of horology.

A steam engine that will run with a variation not exceeding one per cent. is counted perfect, and yet the cheapest nickel-cased watch that exhibited so much divergence from accurate time-keeping would be very properly returned to the seller as useless. The commonest watch should go within (say) 1½ minutes a day, or within $\frac{1}{10}$ per cent. variation, while a good one should not gain or lose more than 10 seconds,—say $\frac{1}{100}$ per cent. variation. Still better results are attained in those cases in which the highest excellence is sought, irrespective of cost. The steam engineer would be proud if he could succeed one hundredth part so well.

Recent advances in horological art have been principally directed to measuring short periods of time with extreme accuracy. There were plenty of good watches

in the "fifties," but there were none that could be read to a fraction of a second. Our grandfathers had their stop-watches, in which the mechanism could be held or released by pressing a button on the case, but the time occupied in the operation was an indeterminate quantity, and one observation, either at the beginning or at the end of the period, had to be made while the second hand was moving. The increased interest taken in sport, and the desire to differentiate between results differing only by a fraction of a second, led to the introduction of the "split seconds" chronograph, in which it is possible to read to a fifth of a second, provided, of course, that the observer has no "personal equation," or that it is equal at both ends of the period to be measured. This form of watch is not so recent as to be a novelty, but it involves much ingenious mechanism not generally understood.

The long seconds hand in a chronograph watch does not, of course, move at ordinary times, when the watch is in the pocket. In this respect, and in many others, it differs from the seconds hand of the ordinary stop-watch. If desired, it can be put in permanent engagement with the train, but it is contrary to the intention of the maker to keep it in rotation without a special object.

An explanation of the mechanism by which these results are obtained follows; but we pass this to note what is said of non-magnetizable watches. These are a necessity to all dealing with electric apparatus, and within the last year or two they have received great improvement. The difficulty was to find a material for the hair-spring that was non-magnetic, and yet reliable for time-keeping purposes. An alloy of palladium is now used, and has given so successful results that non-magnetizable watches can now be made to obtain the highest marks for class A certificate at Kew. The test includes submission to a temperature range of from forty deg. to eighty-five deg., to exposure in an intense magnetic field, and to forty-five days' rating in every possible position. When it is remembered that, out of the millions of watches made annually, only some two thousand are thought good enough to face the Kew test, and that out of these only fifteen to twenty per cent. secure the A certificate, it will be understood how excellent these non-magnetizable watches can be made. Last year a gold minute and split seconds chronograph watch with non-magnetizable balance, constructed by Messrs. Smith, obtained, in the temperature tests at Kew, 19.7 marks out of a possible 20; that is, it was almost theoretically perfect. It was selected for special mention in the *Annual Year-Book of the Proceedings of the Royal Society*.

Cast-Iron Grafting.

As a rule, success in casting a mass of iron so that it fuses upon and becomes an integral part of another piece previously cast and placed in the mold has not been so great as to encourage most founders to undertake the job. The secret of the matter appears to lie in the fusing of a portion of the cold piece to a sufficient depth at the place where it meets the new metal; and it seems that the composition of the new metal ought to be the same, at least approximately, as that of the old.

The fusion of the old metal to a sufficient depth requires that the new metal should be of enough larger quantity than the volume of the part to be grafted on to allow its running steadily over the part of the cold metal to be fused for the time required to effect the fusion; that the metal poured to effect the fusion should be hotter than is required for the ordinary casting of the piece to be grafted on; that the mold should be of a character to resist and stand up well under this higher heat; and that provision should be made for the free running off of the superfluous molten metal used to heat the cold part to the fusing point, and also for suddenly stopping this flow when the fusion has proceeded to the desired limit. As a practical economy, it is well also to provide for receiving in ladles the superfluous metal, and using it for filling other molds where a colder metal will answer.

Every one of these practical points is illustrated in the operation of grafting

wabblers upon eight-inch train rolls as carried out with entire success by Mr. W. L. Hayden, and described by him in *The Foundry* (July) as follows:

"Everyone familiar with the hard wearing strain that these parts are subject to will be interested in knowing that grafting can be done so as to insure practical results. In the first place, we drill and break off the part which may be left of the wabbler, so that it is almost flush with the journal bearing. The fragment of the wabbler thus having been removed, we chip off this fragment in a thorough manner, so as to remove all rust where the melted iron comes in contact. A pit is then dug in the ground of such depth as to receive one-third of the roller, and is rammed with sand, so as to keep the roller in a perpendicular position. It is best to place a level on the journal bearing, to obviate an uneven pressure when the iron is poured. Having made a pattern of the wabbler and journal bearing, we are able to make a perfect dry sand mold similar to any dry sand core. The outside diameter of the mold should be the same as that of the roll, so that it will stand perpendicularly. We then place the mold over the journal bearing, putting paste and sand where it forms its bearing on the shoulder of the roll. The dry sand mold should have a tap-hole even with the surface of the journal bearing, where the grafting takes place, so that the iron fed from above can escape, after flowing over the iron surface at the bottom. At the top a runner notched through the mold is cut to let the overflow escape in one direction and into a receiving bed below, after the tap hole is plugged. We next take three parts of a round iron flask large enough in size to allow about a three-inch clearance, and slide them down over both the mold and the roll, until it stands about three inches above where the mold and the roll join. The clearance then is filled with sand and rammed, so as to strengthen the mold on the shoulder. We then build up with iron flasks, weights, or anything suitable, until even or almost so with the tap hole, covering the top plate with green sand and forming a runway for the bottom waste to feed into the ladle placed below, to be carried away and used in some mold that the deadness caused by the process does not harm. This saves any waste of iron. Now that things are placed properly to receive the iron, we can proceed, as follows: about three to four bull ladles of cold-blast iron are poured respectively into the top of the mold, tapped directly into the ladle from the cupola, so as to obtain iron of the highest possible heat.

"This iron passes completely over the surface below, and should be continued until the cold iron is melted to about three inches in depth. This can be easily determined by sounding with a small iron rod, and subtracting the difference in depth from the top of the mold at the beginning from the increased depths as the process continues. The amount of iron to be used cannot always be determined, as success is due entirely to bringing the cold iron to a heat of 3,477 degrees F., or over, thereby insuring a perfect and homogeneous combination of old and new iron. These rolls were not rapped out for one day after pouring, so as to allow the iron to anneal somewhat. They were put a week afterwards in their respective places in our rolling mill, and two hundred tons of quarter-inch steel rods were rolled from one and three-eighths billets without a mishap. When taken out, there was no impression whatever from the severe test, and it was noticed particularly that the coupling boxes showed marked signs of the severe work undergone."

The Serpollet System.

THE Serpollet system of propelling horseless carriages appears to have been the most successful system yet exploited. A large number of these cars are said to be running in Paris and its vicinity, and the cost of running, according to *Engineering Mechanics* for July, averages 5½ cents per mile as compared with 9½ cents per mile by systems formerly employed. It is added that many more Serpollet cars are soon to be placed in service.

The key to the mechanical success of this system undoubtedly lies in the very ingenious steam generator employed, in

which steam is generated almost instantaneously and with a degree of safety that compares favorably with that of steam boilers of older construction. Small quantities of water are flashed instantaneously into steam, the form of tubes—steel or copper—being that which results from flattening a cylindrical tube until a narrow passage—called "a capillary space"—is formed. "A sufficient number of these flattened tubes placed in a fire-box constituted the generator at first, but at present a sufficient number of steel tubes are assembled in U shapes, ends circular and threaded, connected at ends for free circulation. Only the flattened or capillary portions of the tubes are exposed to the direct action of the fire, the ends and connecting pieces being beyond its action, and therefore subjected to far lower temperature. The tubes are capable of sustaining working pressures beyond 100 atmospheres and in extreme temperatures. Amongst many official trials carried out to test the strength of these elements, the following may be mentioned. One end of the tube was hermetically sealed, and the other was connected to an hydraulic pump. The tube was then placed in a forced fire and raised to a red heat, and was then subjected to a pressure of 200 atmospheres; under this extreme test it was impossible to detect any deformation that could be measured by gage. By a ministerial decree dated October 13, 1888, the Serpollet generators are licensed to work at a pressure of 94 atmospheres.

"Proceeding gradually during the last eight years, the Serpollet generators, at first only made of 2 and 3 horse-power, are now constructed, in large numbers, of 25 horse-power; and, instead of being only able to drive a tricycle weighing 700 pounds, they are largely used for high-speed cars weighing 20 tons. Cars holding six persons are operated at a cost of six cents per mile."

Of course, an active circulation has to be maintained in these flattened tubes. A pump is, for this purpose, driven from an eccentric on the forward axle of the car. A starting pump is placed in the driver's compartment.

The transmission of power from the motor to the driving wheels is by a chain and sprocket attachment, analogous to that so successfully applied to the modern bicycle. The system has proved equally good for tramway cars and carriages run upon the ordinary highways.

The Vibration of Engine Foundations.

IN treating this subject Mr. James Whicher (*The Electrical Review*, London, July 17) takes the broad ground that no amount of elaboration of foundations affords a safeguard against vibration, and that this safeguard is to be reached only by a perfect balancing of the engines themselves. In illustration of this proposition, he imagines a single crank unbalanced engine of, say, ten inches stroke, with reciprocating parts weighing five hundred lbs. while engine and foundation block together weigh five hundred times as much. Then, if the whole be considered as floating entirely free in space, like Mahomet's coffin, the oscillations of the piston must, by the elementary laws of dynamics, produce a counter oscillation in the larger mass, the "stroke" or amplitude of which will be 1-500th of ten inches, or .02 inch. If the centre of gravity of the larger mass be not in the line of motion of the smaller, there will be a considerable tilting oscillation also, covering, in fact, an angle equal to that subtended at the C. G. of large mass by the stroke of the C. G. of the small mass; and the direction of the oscillations in space will be changed into the line joining the C. G.'s at the moment of starting from rest.

When the foundation block is firmly imbedded in the ground, its oscillations will be damped, but in what degree it is impossible to surmise. It becomes the source of vibration waves propagated through the earth around, in some respects as sound waves would be, and with the same velocity, —but chiefly as surface waves. Wave motion implies a growing lag of phase of the oscillations of masses, as farther distant from the source. Wherefore, in a perfectly elastic medium, it is a balanced motion, the sum of all the momenta being nil.

It is not deemed safe to trust to the earth

to eliminate these vibrations before they reach a point where they may be objectionable. The vibrations are considered almost entirely due to the action of reciprocating parts, and, in balancing these parts, it is necessary to consider, not merely the actual motions, but their resultants. Here the author strikes the keynote of all perfect balancing of moving parts; the action of the counterbalance must be in a direction opposite to that of the resultant of motion of the parts to be balanced,—a fact not well understood by many constructors, who thus place their counterbalances in ineffective positions. In a continuation of the discussion this point is elaborated.

Testing Lubricating Oils.

A CHEAP, simple, and easily-manipulated device for testing lubricating oils was recently presented in *American Machinist* by Mr. W. E. Crane, from which description the following is condensed.

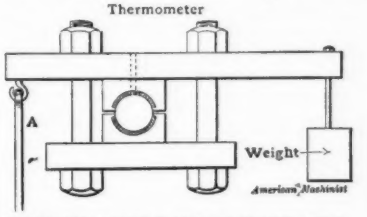
"Get a box at least as long as the diameter of the shaft; have it babbitted, and drill a hole through the top and nearly through the babbitt, so that a thermometer will nearly reach the shaft.

"Put a clamp on the box as shown, having one side long, so as to have a hinged support fastened to the floor on the short end and a weight on the long end. Provide a sight-feed oil-cup so as to feed a certain amount of oil for, say, ten minutes.

"If you have a standard oil, screw the clamp together, adding weight as necessary, until in the ten minutes the temperature will rise twenty-five degrees, or thereabouts."

To test any other oil for lubrication with reference to the standard selected, adjust the feed to the same rate, tighten the clamp till the weight is lifted, and note the rise in temperature.

Of course, there are other qualities desirable in lubricating oils besides lubricating power,—to wit, their degree of liquidity in cold weather, their behavior when agitated with water in cases where oil and water may get mixed as in some steam engines, and the ease with which the oil may be filtered to render it again fit for use when collected from drips, etc. Mineral oils filter best, and do not form emulsions with water, like animal oils, but they heat up quicker in the testing. Mr. Crane says that, in a mill where the oil is not to be filtered, the oil showing least rise in temperature is best, provided that it feeds well, does not gum, and is sufficiently liquid for use in cold weather.



FRICTION DEVICE FOR TESTING OILS.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Mechanical Engineering in the American, English and British Colonial Engineering Journals—See Introductory.

The Machine Shop.

7272. Cast Iron Grafting. W. L. Hayden (How wobblers may be grafted on to 8-in. rolls and be made to endure all the wear and strains required. Interesting and instructive description with illustrations). Foundry–July. 500 w.

7351. Machine for Shaping Sprocket Wheels by Broaching (Illustrated description of a machine for broaching all the teeth of a bicycle sprocket wheel at one stroke). Am Mach–July 30. 400 w.

7354. Walker's Magnetic Clutch for Drill Presses (Illustrated description of clutch as applied to a drilling machine). Am Mach–July 30. 400 w.

7421. Points in Shop Management. B. F. Fells (Need of thorough-going, alert mechanics. Shiftless ways in some shops lately seen). Ir Tr Rev–July 30. 1100 w.

7514. Lathe Work Support. John Randol (Illustrated description of a support used in making long screws). Am Mach–Aug 6. 500 w.

*7529. Electric Wheel Welding Machine (Illustrated description of a machine for welding up wheels with metal hubs and spokes). Ind & Ir–July 31. 1000 w.

We supply copies of these articles. See introductory.

Steam Engineering.

7035. Operating Engines without a Natural Supply of Condensing Water, or the Continuous Use of Injection Water. E. J. Philip (The leading points as at present practiced). Can Elec News–July. 2000 w.

7048. Smoke Prevention from a Mechanical Standpoint. C. H. Benjamin (Extract from paper read before the Civil Engs.' Club of Cleveland. The essentials of a good smoke preventing device, and causes for failures in mechanical stokers as smoke preventing devices). Safety V–July. 1500 w.

7092. Tests of the Efficiency of an Injector. Karl Andréa (Results and tabulated data obtained from a series of experiments upon a Penberthy injector). Eng News–July 16. 700 w.

7108. Tests of Two Systems of Firing on a Water-Tube Boiler (Records of two tests conducted by George H. Barrus at the Edison Electric Illuminating Co.'s Atlantic Ave. power station, Boston, Mass. which had for an object a comparison of two systems of firing,—the common method of spread firing and a coking system in connection with a brick roof over the front of the furnace. Data show superiority of spread firing). Eng Rec–July 18. 600 w.

†7167. Boiler Inspection (Proposed addition to existing rules, as they relate to shells and riveting). Ind Engng–June 20. 2500 w.

7238. The Coming Boiler (The water-tube boiler is treated as a mechanical necessity, since the safe limit of pressure for the cylindrical boiler has been reached. Abstract of address by G. B. Hartley, before the Boilermakers' Assn.) Min & Sci Pr–July 18. 600 w.

*7275. The Vibration of Engine Foundations. James Whitcher (The proposition toward which the argument is directed is that elaboration of foundations affords no security against injurious vibrations, which can only be obtained by perfect balancing of the engine plant). Elec Rev, Lond–July 17. Serial. 1st part. 1400 w.

*7290. The Evaporative Condenser for Steam Engines (The first part contains general remarks and illustrated description of appliances). Mach, Lond–July 15. Serial. 1st part. 2000 w.

*7295. The Commercial Efficiency of Steam Boilers. A. Hanssen (Read before the Civil and Mechanical Engs. Soc. The author utilizes material supplied during the past ten or fifteen years of experimental investigation, particularly that derived from experiments of Donkin, Kennedy, Unwin, Kestner and Déry,—for the determination of a form of boiler that will produce steam most cheaply, and to arrive at conclusions as to the extent to which cheap steam production must be sacrificed to other considerations). Engng–July 17. 3200 w.

7352. Snap Piston Rings. F. A. Halsey (Directions for fitting, with diagrams). Am Mach–July 30. 1200 w.

7406. Fly Wheels for Steam Engines. E. F. Williams (Discussion of the proper proportion of wheels under certain specified conditions, with rules for their construction and performance). Elec Engng–Aug. 3000 w.

7426. New Vertical Cross Compound Engine at Whitman Mills, New Bedford, Mass. (Illustrated detailed description). Power–Aug. 1400 w.

*7432. On Smokeless Combustion and Boiler-Firing. W. Hempel (Abstract from *Stahl und Eisen*. The author combats the statement commonly made in text books that the two compounds, carbon monoxid and carbon dioxid, result in combustion according to the quantity of air supplied to the fuel, and holds that the character of the products depends also upon conditions of temperature and pressure). Col Guard–July 24. 700 w.

7513. Quick-Opening Throttle Valves. Peter H. Bullock (The author believes that while, as a rule, throttle valves should be operated slowly, provision for operating them quickly ought also to be provided for use in cases of emergency. He illustrates and describes means for doing this, of his own devising). Am Mach–Aug 6. 700 w.

7515. Some Features about the Belgium Engines of H. Bollinckx. John E. Sweet (Illustrated description, with comments upon the system of active steam jackets, which is a feature of these engines). Am Mach–Aug 6. 1300 w.

Miscellany.

*7009. Chronograph Watches (Recent advances in the horological art. Measuring short periods of time with extreme accuracy). Engng–July 3. 2200 w.

*7044. The Duty of Pumping Engines. Dugald Baird (Read before the Mining. Inst of Scotland. Easy method of finding duty, with a few examples). Can Min Rev–June. 3500 w.

†7053. The Air Lift Pump. C. C. Stowell (Deals with the early history of raising water by air lift, its general principles, and with an installment, at Rockford, Ill., with illustrations and discussion). Ill Soc of Engs & Surv–11 An Rept. 2800 w.

†7054. The Hydraulic Ram for use in Public Water Works Systems. Daniel W. Mead (The author thinks this machine is less perfectly understood than almost any device that has been so long before the public, and this paper is an explanation of its principle and action and illustrates and describes existing forms. Discussion). Ill Soc of Engs & Surv–11 An Rept. 4500 w.

7094. New Foundry of the Niles Tool Works, Hamilton, O. (Illustrated description). Eng News–July 16. 600 w.

†7201. The Theoretical and Measured Pumping Power of Windmills. E. C. Murphy (A contribution of data and formulæ to the art of constructing and operating windmills). Am Soc of Ir Engs–April, 1895. 3500 w.

7203. About Test Sections. P. Kreuzpointner (An argument in favor of using as large size test pieces of metal as is practicable). Ir Age–July 23. 2200 w.

7214. Pneumatic Power in Workshops. John Davis Barnett (A paper read before the Canadian Soc of Civ. Engs., Toronto. Qualitative

rather than quantitative results are dealt with; the author stating that reliable data for quantitative results are, in his opinion, not at present obtainable. Discussion). Can Eng-July. 6000 w.

7215. The Power of the Future. Thomas Frood (Steam is considered as having had its day. Gas and electricity are now contending for supremacy and at present the author believes gas has the lead, but he thinks electricity will win in the long run). Can Eng-July. 1500 w.

7216. A Question in Mechanical Design. R. W. King (The question discussed relates to screw threads of bicycle pedals. Which side of the bicycle should be the pedal with the left hand thread?). Can Eng-July. 1000 w.

7227. The Bicycle (Illustrated history, beginning with the tandem wheeled hobby-horse of the last century). Sci Am-July 25. 1800 w.

7229. The Sewing Machine (History from the date of allowance of Elias Howe's application for U. S. letters patent, in 1846, to the present time. Illustrations of the earlier machines). Sci Am-July 25. 3000 w.

7230. Agricultural Machinery (History of reaping machines). Sci Am-July 25. 4200 w.

7232. Fifty Years in the Printing Business (Illustrated historical sketch). Sci Am-July 25. 1700 w.

7273. How to Gain a Knowledge of the Nature of Cast Iron (Plain pointers upon practical iron founding, in the form of questions and answers). Foundry-July. Serial. 1st part. 1800 w.

*7279. Machinery Bearings. John Dewrance (The results of a series of experiments undertaken by the author to determine the frictional resistance to shafts revolving in bearings under varying loads when subjected to different conditions). Ind & Ir-July 17. 3800 w.

*7280. Gas Engines as Economical Motors. J. Holliday (The first part contains general remarks; discusses the advantages of subdivisions; comparison of systems. etc). Prac Eng-July 17. Serial. 1st part. 2000 w.

*7294. The Training of Apprentices (The system in use in the French railway workshops. The idea is to educate the apprentice in theory, simultaneously with his manual training). Engng-July 17. 1100 w.

7346. The Making of a Band Saw (Illustrated description). Ir Age-July 30. 2000 w.

7348. The Repair of Single Tube Bicycle Tires (Several methods of repair are described, with numerous illustrations). Sci Am-Aug. 1. 2000 w.

7355. Uses and Advantages of a Public Supply of Compressed Air. Frank Richards (Explanation of a way whereby water motors may be used in connection with a supply of compressed air). Am Mach-July 30. 1200 w.

7364. A Steel Framed Wheel 100-ft. in Diameter (Illustrated detailed description). Eng News-July 30. 400 w.

7366. The Evils of Fictitious Accuracy (A severe editorial criticism of methods adopted by some engineers, which assume to give greater accuracy in statement of results than the limits of error will justify, or that can be practically useful). Eng News-July 30. 1600 w.

*7387. A Water Power and Compressed Air Transmission Plant for the North Star Mining Company. Grass Valley, Cal. Arthur De Wint Foote (Abstract of paper read before the Am. Soc. of Civ. Engs. General description). Am Eng & R R Jour-Aug. 2200 w.

†7389. Sharp's Shaft Coupling (Coupling invented and designed by Prof. Archibald Sharp of Central Technical College, South Kensington, Eng). Ind & East Eng-July 4. 800 w.

7417. The Introduction of Oil in Bearings (An experimental research). Eng Rec-Aug 1. 1100 w.

7428. Where Shall We Locate the Power Plant? C. C. Dennis (An estimate of cost as affected by location, collaterally touching upon the necessity for steam heating, as an element to be considered in the answer to the question). Sta Eng-Aug. 1400 w.

7484. Testing Machine of 200,000 lbs. Capacity for the University of New York (Illustrated description). Eng News-Aug 6. 500 w.

7485. Heating a Cotton Mill from the Hot Well of a Condensing Engine (Extract from paper by George W. Weeks, read before the New England Cotton Mfrs. Assn. and printed in the *Providence Journal*. Brief description of a blower system for heating and ventilating in which the pipes of the heater are filled with water from the hot well of the condensing engine instead of with steam). Eng News-Aug 6. 2000 w.

*7496. The Manufacture of Power (Editorial reviewing the benefits to mankind due to the discovery of the means to manufacture unlimited power. The intellectual progress of the race not only became possible but a necessity). Engng-July 31. 2800 w.

*7511. Air Compressors. Philip R. Björling (Describes the different types of air compressors, giving illustrations, and states facts regarding their efficiency). Col Guard-July 31. Serial. 1st part. 2000 w.

*7518. Chains and Chain Iron. G. N. Shawcross (Qualities of iron suitable for chains; different kinds of chains; tests for determining quality and the commencement of an illustrated description of processes for manufacturing chains, are the topics presented in part first). Prac Eng-July 31. Serial. 1st part. 3500 w.

*7527. Notes on the Introduction and Development of Rope Driving. Abram Combe (Notes, chiefly historical). Ind & Ir-July 31. 2000 w.

*7552. Flax Scutching and Flax Hackling Machinery. John Horner (Read before the Inst. of Mech. Engs., at Belfast. Illustrated description of machines and processes). Eng, Lond-July 31. 2500 w.

†7561. Aerial Tramways. W. R. Shaw General considerations relating to rope conveyors, and a list of some of the most interesting lines). Ind & East Eng-July 11. 2200 w.

MINING & METALLURGY

The Influence of Metalloids in Cast Iron.

THE Western Foundrymen's Association, following the suggestions of a paper by Major Malcolm McDowell reported in *The Iron Age*, has undertaken a work of striking significance and of almost overwhelming extent. It is, briefly, the actual determination, by an exhaustive series of metallurgical, chemical, and physical tests of the exact influence of all the usual minor constituents,—carbon, manganese, silicon, phosphorus, and sulphur,— not only separately, but in the widest range of varying proportion in combinations of two or more.

At present, as Major McDowell states, the whole subject of grading pig is in the most unsatisfactory and nebulous condition. The supposedly corresponding grade numbers of northern and southern furnaces do not agree, nor is there "a reliable similarity in the corresponding numbers of different furnaces in either section," even though these numbers are supposed to be based on the simple mechanical test of fracture. When it comes to a consideration of actual composition and suitability for different classes of castings, the trade is still further at sea.

Nearly every foundryman has at times made an exceptional metal, but how he did it he does not know, nor has he ever since been able to reproduce it. Others have, by experimenting with different brands of pig iron, produced an exceptional metal, and, as long as they were sure of the same pig, they duplicated it. But what special metalloids acted in combination with the iron they were unable to tell.

That such a state of things is eminently unsatisfactory goes without saying.

The furnaceman and the foundryman are alike interested in knowing the value of each constituent element composing the pig that is made by one and used by the other,—not so much a scientific expression of their value, but a practical demonstration that will enable the one to formulate a specification of his wants that the other may meet the requirements with as much ease and precision as he does the wants of the chemist of the steel maker. As a general thing, the foundryman does not know the chemical constituents of a metal that will make a casting for a special purpose. He buys a metal from the furnaceman that the one thinks and the other hopes will make what they want; neither are certain, both are guessing, each holding the other responsible if it fails, both claiming the honor if it succeeds.

It is to be assumed without question that the furnaceman is just as desirous as the foundryman to reach a more satisfactory and certain knowledge, but facts are not at hand.

There is more or less information scientifically expressed of the nature and relations existing between iron and carbon and the various influences exerted on them by the four different metalloids,—silicon, phosphorus, manganese, and sulphur. This information is not put in so practical a form as to designate the value of these elements in making up a specification for certain grades of metal.

However, there are already indications of the inception of a new order of things. Out of all this anxiety from "guessing" is evolving a new condition. Here and there foundrymen are adding laboratories to their equipment, and the chemists are learning the value of certain metalloids in making special castings.

To confirm and expedite the new era, Major McDowell suggests joint action in carrying on the experiments. "Knowing the great value," he says, "of a knowledge of the relations which exist between different metalloids and iron in making castings, I think it would be advisable to make a series of experiments to determine these relations and their relative values. I would use a cupola that would melt 1,000 pounds an hour, taking 250 pounds on the bed, tapping the latter amount into a ladle

of that capacity, from which I will take the tests necessary. Charcoal should be used as fuel, until the desired metal is found, and then coke or anthracite coal used to determine their effect on the standard."

Under these conditions heats would be made, "keeping all but one of the variables constant, and increasing one metalloid." The first series would be with iron, carbon, and varying silicon; in the next, manganese would be substituted for silicon, the third and fourth would be with both manganese and silicon, first one and then the other being varied. Then phosphorus will be introduced. With the entire series completed and tabulated, there will be demonstrated, as Major McDowell thinks, the effects of the metalloids and their combinations upon the physical, chemical, and metallurgical tests, determining the practical value of each or of a combination of the metalloids in making cast iron in a cupola. The importance of the work suggested appealed at once to the Association, and a committee of three was authorized to carry on the tests and experiments under the direction of the board of directors of the Western Foundry-Men's Association.

The undertaking is stupendous. As *The Iron Age* remarks editorially, "the work, if done exhaustively (and to be valuable it cannot be done otherwise), will certainly extend over several years, requiring patient industry and unselfish devotion" by the members of the committee. It is greatly to be hoped that the work will receive, as it deserves, the suggested assistance and coöperation of the technical schools. They could hardly undertake anything in their laboratories more instructive to the students or more helpful to the iron industries.

Non-homogeneous Alloys of Gold.

AN article by Edward Matthey "On the Liquation of Certain Alloys of Gold, appearing in a recent number of *Nature*, abridged from a paper before the Royal Society, gives some curious and interesting information on the apparent extreme difficulty of securing a homogeneous composition for certain alloys of gold with the baser metals. The subject is described as being invested with considerable practical importance though the new extracting processes which are sending to England, from South Africa especially, "a series of alloys of gold and of the base metals that have hitherto rarely been used in metallurgical industry."

To illustrate the difficulty, Mr. Matthey gives the results of a number of assays of a typical ingot. Four determinations made on a portion of metal cut from an upper corner varied from 465 parts of gold per 1,000 parts to 664 parts per 1,000.

Three assays made of a piece from the bottom of the same ingot gave 652 parts of gold per 1,000 as the highest result, and 332.5 as the lowest.

Evidently, gravity was not the causative agent in the matter, or the gold would have been in larger proportion at the bottom. Still more evidently, there was nothing like uniformity of composition anywhere in the mass.

The whole ingot was then brought into fusion, and small "dip" samples were taken from the thoroughly-stirred molten mass; but these again gave results varying from 562.3 to 653.5, showing that "rearrangement (on cooling) could take place within the limits of a fragment of metal which did not weigh more than a few grams."

Separation of the metals was finally made in mass, showing the actual value of the ingot to be £1,028, while an average of all results would have fixed it at £965,—a very large error.

The actual analysis proved to be:

Gold	61.7
Silver	8.1
Lead	16.4
Zinc	9.5
Copper	4.0
Iron	.3
	100.0

"Suspicion at once fell on lead and zinc as disturbing elements," and a long series of experiments showed that lead exerts a much greater disturbing influence than zinc. More interesting still was the attack

on the problem along the line "of Roberts-Austen's method of fixing the solidifying points of metals on 'cooling-curves' obtained by the aid of thermojunctions connected with autographic recorders. Such curves showed that a triple alloy of lead, gold, and zinc has three 'freezing-points.' The mass sets, as a whole, at a single main point of solidification, but the lead and the zinc associated with some gold retain a certain amount of individual independence, and, by falling out of solution, separately destroy the uniformity of the mass, even though the mass itself be small."

"After a long series of experiments, a metallic solvent was sought which would enter into union with the gold, the zinc, and the lead. Silver proved to be such a solvent,—and solidified alloys of gold, containing not more than thirty per cent. of lead and zinc, may be made practically uniform in composition by adding fifteen per cent. of silver to the mass when fluid."

The diagrams, however, which are appended to illustrate the multiple determinations made on spherical ingots of varying compositions, do not at all bear out this general statement. Fig. 12, which is "alloyed so as to contain fifteen per cent of silver," and therefore should be practically uniform, gives thirteen results, varying all the way from 533.8 to to 595, which seems like anything but uniformity, although it is again specially cited as showing how greatly the arrangements of the alloy has been modified by the presence of the silver.

It is true, however, that it is greatly better than the preceding sample, containing only seven per cent. of silver, which varied from 413.8 to 707.2; but this in turn is far worse than the alloy of 75 parts gold, 15 parts lead, and 10 parts zinc, without any silver at all, which, in five determinations, varied only from 650.7 to 790.8.

On the other hand, zinc alone does not seem to show the disturbing influence attributed to it. An alloy of 95 parts gold and 5 parts zinc gives twelve determinations all lying between 942.7 and 945, and one of 90 parts gold and 10 parts zinc gives twelve results between 899 and 901.5. But both of these results are cited by the author as showing a "decided tendency of liquation of gold toward the center."

Probably, with the full text and complete series of illustrations, the graphic representations would appear more consistent with the statements of the paper. As it is, the figures seem hardly to enforce Mr. Matthey's very interesting investigations and conclusions.

Increased Blast-Furnace Output.

THE age of intensified production has made its influence felt in the iron industry. Not many years ago a furnace making a hundred tons a day, or, at the outside, a hundred and twenty-five tons, was considered a very large producer; about three years since, *Mineral Industry* commented upon the increased output resulting from better ore-treatment and improved practice generally, and reported that Alabama furnaces formerly rated at ninety tons a day were now making one hundred and fifty.

Recent English practice, judging from an address by Mr. E. Windsor Richards before the Institution of Mechanical Engineers, abstracted by *The Iron Age*, makes even these figures seem small. Two hundred tons per day seems to be the readily realizable expectation for a furnace seventy-five feet high with a twenty-foot bosh and a ten-foot hearth, working on a 50 per cent. ore, and twelve hundred tons a week is apparently the ordinary working average for such a furnace.

There seems to be a tendency toward a reversion to a flatter bosh; some details of the abstract are interesting in this connection:

"At Jarrow-on-Tyne a blast-furnace plant was constructed with all recent improvements, from which greatly improved results were expected. As these results were not at first realized, it is of value to ascertain the causes, in order to avoid similar failure in future. The furnace, No. 5, is 75 feet high, bosh 20 feet diameter, having several cooling plates, angle of bosh 80 degrees; hearth, 11 feet diameter; throat, 16 feet; bell, 11 feet; capacity of

furnace, 14,150 cubic feet; eight gun-metal tuyeres, 5½ inches diameter, placed 6 feet above the hearth level. Blast of 3¼ pounds pressure per square inch, heated by four Cowper stoves, 73 feet high and 22 feet diameter, to a temperature of from 1,400 to 1,500 degrees F. Durham coke with 8 per cent. ash and 1 per cent. sulphur, 19½ hundredweight per ton of bessemer pig iron. Production 1,000 tons per week from Bilbao and African ores averaging 50 per cent. of iron, increased to 1,100 tons during the last few weeks. Limestone, 8 hundredweight per ton of pig. One pair of compound condensing vertical blast engines, high-pressure cylinder 54 inches diameter, low-pressure cylinder 72 inches diameter, air cylinders 100 inches diameter, stroke 5 feet, making 17 revolutions per minute for 1,000 tons of iron per week. From such an installation as this it would be expected that a large production would be readily obtained at a low cost; but the furnace worked with great irregularity and was continually hanging and slipping. Increased blast pressures were tried, and failed to produce any improved results. The cause was evidently traceable to the steep boshes. So unsatisfactory and costly was the working that the furnace was blown out in June, 1893, and the boshes were altered to 68 degrees. Since this alteration, the furnace has worked well and economically. The engineering portion of the whole plant is well carried out, For a furnace having such a large reserve of blast and heating power, an output of only 1,100 tons per week cannot be considered a good return for the large amount of money expended.

"In a paper read and discussed at the Middlesborough meeting of this institution in August, 1893, our past president, Jeremiah Head, described a blast furnace of peculiar internal form, designed by Howson & Hawdon of Middlesborough. On visiting last month the works of Sir Bernhard Samuelson & Co. in order to ascertain what success this new form of furnace had attained, I found there are five now in operation, giving such satisfactory results that a sixth is being prepared. Two of the furnaces were making Cleveland iron and three hematite. No. 5 furnace with 18 feet bosh, 70 degrees angle, 11 feet hearth, 84 feet high, had made during the previous ten weeks, with Rubio ore containing 50 per cent. of iron, an average of 1,053 tons per week of good gray bessemer iron with a consumption of 18.1 hundredweight of coke per ton of iron, the coke containing 10 per cent. of ash. The blast is supplied by ordinary vertical compound condensing quick-running engines at about 4½ pounds pressure per square inch, and is heated by Cowper stoves to 1,400 or 1,500 degrees F. By increasing the volume and maintaining the heat of the blast Mr. Hawdon expects shortly to attain 1,200 tons per week.

"The Dowlais Cardiff new blast-furnace plant is remarkable for efficient and economical working. The two furnaces have 20-feet boshes, 10-feet hearths, are 75 feet high, and from Bilbao ores containing 50 per cent. of iron each furnace produces 1,250 tons per week of good gray bessemer iron with a little over 19 hundredweight of coke per ton. The production can be readily increased, should the state of trade require it."

American Mines and British Investors.

WE have heard a good deal of complaint and criticism of American investments by British investors, much of it no doubt well-founded, based upon conditions which every sound business judgment must deplore, and which, we hope, criticism and suggestion may aid us to improve.

But the dissatisfaction which has perhaps too often attended the investment of British capital in enterprises in this country is something for which Americans are not always and altogether to blame. Faulty judgment in placing the money, and unwise operations following, have had their contributing influence, and for these our English cousins must accept the blame.

Mr. Thomas Tonge, whose interesting article on the new gold fields of Colorado appears elsewhere in this number, in a letter to *The Mining Journal, Railway and Commercial Gazette*, seems to divide very fairly the burden of responsibility for many

of the disappointments realized in mining investments. He says:

"Many mining enterprises, good and sound in themselves, placed in England, have proved financial failures to the shareholders by reason of the following:

"1. Over-capitalization. For instance, a property for which the vender receives (say) £20,000, being more than worth every shilling of it, is floated on the British market at (say) £50,000 or £75,000, or even more, with the result that, whereas the property would have paid handsome dividends on a capital of £30,000, no management can make it pay satisfactory dividends on the exaggerated sum at which it is floated.

"2. Exorbitant 'rake off' by promoters and middlemen, which inevitably is at the expense of the duped shareholder. Too many promoters are not content with a fair remuneration for their trouble, but look for big profits from unloading stock and not from ore shipments.

"3. Excessive office and directors' expenses at the English headquarters, even though involving the curtailing of necessary expenses at the mine. The wealthiest and most experienced and successful mining men in Colorado do not waste their time on public stock companies with the minimum of efficiency and the maximum of red tape formality and office expense, but form themselves into small private syndicates or companies, the capital being furnished by themselves and a few personal friends, and the money put into efficient work on the properties.

"4. Inexperienced and incompetent mining engineers, managers, &c., usually relatives or connections of the directors, sent out to report upon or manage, or in some way draw a salary at, the mine. There are in Colorado considerably over a dozen mining engineers and experts, both British and American, of many years' local experience and unblemished reputation, who must of necessity be more competent to pass opinions on the merits of a mining property in Colorado than any man sent from England to Colorado, possibly for the first time, and at best only an occasional and transient visitor. British capitalists would do well to utilize to a much greater extent Colorado mining engineers and experts, and, judging by past experience, would save large sums of money by so doing, not merely in the travelling expenses from England, but in the better and more reliable advice they would frequently get. Moreover, Colorado mines should not be utilized as eleemosynary institutions for younger sons and failures from England."

Mr. Tonge's last point is especially well taken. It is not unnatural for a foreigner to turn instinctively for advice to an expert of his own nationality, but in the great majority of cases he would do vastly better to consult a reputable American engineer, whose entire education, both direct and indirect, has familiarized him, not only with the obvious elements of the case, but also with the less evident conditions involved in the problem of success.

The Mining of Talc.

THE COLLIERY GUARDIAN gives some interesting notes, abstracted by the Institution of Civil Engineers from a paper by P. Pillez in *Comptes Rendus de la Société de l'Industrie Minérale*, 1895, on the "talc quarries of Luzenac."

The abstract gives valuable information regarding a minor-mineral about which but little is generally known, especially in proportion to its exclusive use. We give the abstract in full:

"At Luzenac, in the upper valley of the Ariège, talc is quarried on an extensive scale in the granite of Saint Barthélemy, a mountain 7,700 feet high, and about 20 miles from the main chain of the Pyrenees. The quarries, which are situated about two miles from the summit, and 5,900 feet above the sea, are opened in a bedded deposit, included between mica-schist below and lower silurian slates above, which has been followed for about 2,000 yards in a north-south direction, with a dip of about 60 degrees to the east, the thickness varying from 160 to 1,000 feet, as does also the composition. Masses of limestone and granite, the latter often of considerable size, are frequently found included in the silicate of magnesia, which also contains some alumina, as shown in

the following analysis A, while B gives the composition of the talc of the valley of Pignerolles, in Italy, which has a high reputation for quality.

	A.	B.
Silica	61.85	60.60
Magnesia	34.52	35 30
Alumina	2.61	0.30
Ferric oxid	0.25	0.60
Lime	Trace	0.40
Combined water	0 60	Not determined
Alkalies and loss	0.17	2.80

"The best rock is of a brilliant white color, and feels greasy to the touch when ground to fine powder. The principal quarry, at Tremouin, is worked in the open, across the direction of the bed, forming two or three terraces, 50 feet high, the surface covering, 6 to 10 feet thick, having been first stripped. The stuff broken is carried by a level, in the bottom of the quarry, driven in the foot-wall of the vein, to the valley of Axiat, whence it is hauled in bullock wagons about 12 miles to the works at Luzenac, where a water-power of 90 h.p. is obtained from the Ariège. The mechanical preparation includes sizing by sieves, drying in a rotating-cylinder furnace, breaking, grinding, and sifting. The grinding is done in ball-mills, which rarely require to be stopped for repairs. Nearly the whole of the product is converted into powder, only a small part being made into pencils for marking out work on metal or sold in the lump form. The consumption extends to almost all parts of Europe and America. The principal applications are in soap-making and perfumery, paper-making and weaving. It also forms an ingredient in wagon grease, and is used as an insulator for electric conductors. A new preparation called cupro-steatite, made by mixing talc and sulphate of copper, is now being tried with success as an insecticide in vineyards."

THE Australian *Mining Standard* chronicles the completion of an eleven hundred foot ventilating tunnel in the Great Southern tin mine, Toora, South Gippsland. The mine itself "promises to be highly remunerative, and bids fair to remove the prejudice that Victoria is not a tin producing country.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Mining and Metallurgy in the American, English and British Colonial Mining and Engineering Journals—See Introductory.

Metallurgy.

*6983. Are the Cyanid Patents Invalid? J. S. C. Wells (Contending that the processes of dissolving gold in cyanid and of precipitating it by zinc are public property). Eng Mag–Aug. 3700 w.

6989.—75 cts. Melting Points of Aluminum, Silver, Gold, Copper, and Platinum. S. W. Holman with R. R. Lawrence and L. Barr (Presented at meeting of the Amer. Acad. of Arts and Sciences. The melting points are offered as provisional only, but with the belief that they are more reliable than previous data. Methods and apparatus are illustrated and described). Tech Quar–March. 4800 w.

7077. The Iron Industry of Southern Russia (From report of M. Trasenster, printed in the *Revue Universelle des Mines*. Treats of the ore deposits and iron and steel works). Ir Age–July 16. 3800 w.

*7110. Blast Furnaces, Past and Present (Part first reviews briefly the past history of this industry). Ir & St Trds Jour– July 4. 1600 w.

*7137. American Blast Furnace Practice. Jno. L. Stevenson (The first paper gives particulars, with drawings, of a blast furnace plant for a minimum nominal make of 200 tons per day of twenty-four hours, per furnace, from ores containing 50% of iron for which the furnaces were designed. Specifications of a plant of two furnaces built in the United States). Eng, Lond –July 10. Serial. 1st part. 3000 w.

7154. Steel Making at Birmingham. P. G. Shook (Extract from paper read before the Alabama Industrial and Scientific Society. Relates to the availability of raw material required for basic open hearth steel manufacture in Alabama). Ir Tr Rev–July 16. 1300 w.

7202. Practical Value of the Various Metalloids in Cast Iron. Malcolm McDowell, with Editorial (Results of researches and experiments, followed by brief discussion). Ir Age–July 23. 4500 w.

7252. Concentration of Low-Grade Iron Ores. William B. Phillips (An account of difficulties encountered with this class of material, experiments and investigations. A future article will give an account of experiments with the Wetherill concentrating process). Eng & Min Jour–July 25. Serial. 1st part. 1200 w.

7253. Matte Smelting in California. Herbert Lang (Description of the smelting works at Keswick, Cal). Eng & Min Jour–July 25. Serial. 1st part. 3000 w.

*7297. On the Liquation of Certain Alloys of Gold. Edward Matthey (Abridged from a paper read before the Royal Society. Calls attention to very irregular distribution of the metals in alloys of gold, zinc and lead, and sug-

gests addition of silver to secure homogeneity). Nature–July 16. 1000 w.

†7325. Middle-Product Jig. E. G. Tuttle (Illustrated description of a jig arranged for separating the middle product or middlings obtained in the concentration of certain ores, minerals, coal, etc., with adjustable and automatic discharges for the middle and lower products). Trans Am Inst of Min Engs–July. 1700 w.

†7326. Eccentric Jig, with Adjustable and Automatic Lower Discharge Arranged for the Full Width of the Bed and for One or More Compartments. Edgar G. Tuttle (Illustrated description). Trans Am Inst of Min Engs–July. 1800 w.

†7327. A Mechanical Coke-Drawer. Robert A. Cook (Illustrated description of a device by which the coke from bee-hive ovens is extracted with a minimum of manual labor). Trans Am Inst of Min Engs–July. 1000 w.

†7328. The Newton-Chambers System of Saving the By-Products of Coke-Manufacture in Bee-Hive Ovens. Robert A. Cook (A brief history of the development at Sheffield, Eng., of a most successful system of the utilization of by-products in connection with an already existing plant of bee-hive ovens). Trans Am Inst of Min Engs–July. 1200 w.

†7332. The Sulphuric Acid Process of Treating Lixiviation Sulphides. Frederic P. Dewey (Description of the Dewey-Walter process and its application, with its advantages). Trans Am Inst of Min Engs–July. 7500 w.

†7333. Action of Blast Furnace Gases Upon Various Iron Ores. O. O. Laudig (Experiments made in the laboratory of the Buffalo Furnace Co). Trans Am Inst of Min Engs–July. 2700 w.

†7336. Notes on the Walrand-Legénisel Steel-Casting Process. H. L. Hollis (Brief statement of process with some recent changes in practice). Trans Am Inst of Min Engs–July. 1700 w.

†7337. The Cycle of the Plunger-Jig (Communications in discussion of the paper of Prof. Robert H. Richards, Boston, Mass., presented at the Pittsburg meeting, Feb., 1896). Trans Am Inst of Min Engs–July. 1800 w.

†7338. The Accumulation of Amalgam on Copper Plates (Communications in discussion of the paper of Mr. R. L. Bayliss, presented at the Pittsburg meeting, Feb., 1896). Trans Am Inst of Min Engs–July. 3500 w.

†7339. The Physics of Cast Iron (Continued discussion). Trans Am Inst of Min Engs–July. 7500 w.

†7404. The Conditions which Cause Wrought Iron to Be Fibrous and Steel Low in Carbon to Be Crystalline. W. F. Durfee (Observations and conclusions derived from practical acquaintance with the manufacture and employment of iron and steel. Contributive to a correct understanding of the structural relations or as indicative of their proper treatment). Jour Fr Inst–Aug. 13000 w.

*7431. The Preparation of Chemically Pure Iron. W. A. McGillivray (From Journal of West of Scotland Iron and Steel Inst. Investigation carried out on the suggestion and under the supervision of the late Prof. William Dittmar). Ind & Ir–July 24. 3000 w.

7435. Standard Specifications for Structural Steel (Specifications are given in full as adopted by the Assn. of Am. Steel Mfrs). Eng & Min Jour–Aug 1. 1500 w.

*7479. An Improved Process of Extracting Gold Ores (Describes the process patented and perfected by J. W. Bailey, of Denver, Col., and the experimental plant in operation at Cripple Creek). Aust Min Stand–July 2. 1500 w.

*7497. The Action of Blast in Cupolas. Thomas D. West (Paper read before the Western Foundrymen's Assn., Chicago. Power of blast penetration and improvements in center blast). Engng–July 31. 2700 w.

*7530. Description of the Alumina Factory at Larne Harbor. James Sutherland (Read at the Belfast Meeting of the Inst. of Mech. Engs. Detailed description). Ind & Ir–July 31. 2400 w.

*7551. The Iron and Steel Works of the United States (Items taken from the introduction to the "Directory of Iron and Steel Works," respecting the development and present numbers of works and manufacturing plants in these industries). Eng, Lond–July 13. 1600 w.

Mining.

6996. Quartz and Placer Deposits in British Guiana. Charles E. Clarke (Description of the country generally and of the Barima district in particular). Eng & Min Jour–July 11. 2400 w.

6997. The Broken Hill Silver Mines in Australia (An account of the silver production region of New South Wales. Some statements taken from the Melbourne *Argus*, the figures being supplemented and corrected by the companies). Eng & Min Jour–July 11. 2000 w.

*7017. On Gold Mining in Rhodesia, British South Africa. William Fischer Wilkinson (Experiences of the writer during a visit of two months duration, at the latter end of 1895. The best way of reaching the country, the geographical position of the gold fields, a list of the principal fields with the names of some of the prominent mines, the geology, mining laws of the country, and evidence of past workings, are some of the subjects receiving attention). Jour Soc of Arts–July 3, 4400 w.

*7045. Notes on the Eustis Mine, Que. Raoul Green (Paper awarded prize of $25, being first in a series of students' competitive papers read before the Gen. Min. Assn. of Quebec. It is the result of careful observation while working in this mine). Can Min Rev–June. 2500 w.

*7046. The Lighting of Collieries by Electricity (The value of electricity for this purpose, the conditions of underground lighting, the difficulties and suggestions, with some examples). Can Min Rev–June. 2500 w.

7128. Trail Creek. David B. Bogle (The progress and extensive development of this camp)., Eng & Min Jour–July 18. 1100 w.

*7157. Telluride, Colorado. T. P. Van Wagenen (The first part consists largely of a description of the country, the formation and lo-

cation of the mines). Min Jour–July 11. 1700 w.

7205. St Elmo and Chaffee County (Illustrated description and general information regarding these mines). Min Ind & Rev–July 16. 3500 w.

7254. "La Brilladora" Mine, Jalisco, Mexico. James L. Buskett (Illustrated description). Eng & Min Jour–July 25. 600 w.

*7256. The Kent Coalfield. F. Brady, G. P. Simpson, and N. R. Griffith (From the results of the investigations made it appears that there is enough coal to supply 30,000,000 tons per annum for the next 100 yrs). Coal Guard–July 17. 1100 w.

*7300. Coal Mining Puzzles (The present position of the coal trade of Great Britain, and the causes. Editorial). Eng, Lond–July 17. 1400 w.

*7303. Gold in Western Australia. Charles J. Alford (Conditions of deposition, characteristics, process of working, veins, surface deposits, and other related topics are treated briefly). Min Jour–July 18. 2500 w.

*7304. Mining in Asturias (Spain).—The Cinnabar Zone (Description of work in this most important of the coal fields of Spain). Min Jour–July 18. 1100 w.

*7305. Notes on the Cost of Mining and Earthwork in Asia Minor, Persia, and Burmah. T. Trafford Wynne (Statistics of the cost of labor in various mining operations in countries not often visited). Min Jour–July 18. 1600 w.

†7334. Coal Dust as an Explosive Agent. Donald M. D. Stuart (Reply to criticisms made in discussion of the theory advanced by the writer, with further statement of his views formed from further investigations). Trans Am Inst of MinEngs–July. 9500 w.

†7335. Copper Ores in the Peronian of Texas. E. J. Schmitz (Report of the territory examined, description of ore, and its deposition). Trans Am Inst of Min Engs–July. 2800 w.

7362. The Gold Belt of Gunnison County, Colorado. Thomas Tonge (Information obtained personally by the writer during two visits, examining the mines and prospects of the belts, which is about 65 miles long and 15 miles wide). Min & Sci Pr–July 25. 1500 w.

*7376. The Cripple Creek Goldfield (Descriptive of the country, and reviewing the changes of the past five years). Aust Min Stand–June 11. 2000 w.

*7377. The Zeehan-Dundas (Tas.) Mineral Fields (Extract from report of the Tasmanian mines inspector. Information as to some of the geological features, with correction of statement previously made regarding concentration losses). Aust Min Stand–June 11. 1800 w.

*7384. The Trail Creek District, B. C. (Full illustrated description of these rich mines). Can Min Rev–July. 10000 w.

7436. Angels Camp, California, and Vicinity. H. L. Tyler (Account of the mines of these districts, with maps). Eng & Min Jour–Aug. 1. 1400 w.

7437. Mineral Regions of British Columbia. H. M. Beadle (Illustrated description of the country within a few miles of Rossland). Eng & Min Jour–Aug. 1. 1000 w.

*7446. A Victorian Mount Morgan (Account of a very rich field recently found in Australia). Min Jour–July 25. 1800 w.

*7447. The "Wild West Coast" of Tasmania. F. E. Harris (The first part is largely descriptive of this country of vast mineral wealth). Min Jour–July 25. Serial. 1st part. 3200 w.

*7448. Gold Mining in Colorado as an Investment. Thomas Tonge (Favorable account and claiming there is no better opening for the judicious investment of capital). Min Jour–July 25. 1800 w.

*7455. The Mining Boom in Tasmania (Report by Mr. Montgomery on mines that have been worked for some time). Aust Min Stand–June 18. Serial. 1st part. 6300 w.

7504. Elkhorn Mountain and Rock Creek District of the Blue Mountains, Oregon. Robert W. Barrell (Description of this district, which the writer considers a very favorable field for capital to invest in mining). Eng & Min Jour–Aug. 8. 1500 w.

*7540. The Mining in and Around Herberton, North Queensland. John Munday (Paper contributed to the Aust. Assn. for the Advancement of Science. Describes lode mining and alluvial mining in this locality, and machinery used). Min Jour–Aug. 1. 2800 w.

*7541. Notes on the Explosion of Coal Dust. W. J. Orsman (From a paper recently read before the Federated Inst. of Min. Engs. A review of demonstrated facts with other information). Min Jour–Aug. 1. 1500 w.

Miscellany.

*7039. The Carriage of Coal on Railways and Canals (The essential statutory provisions on the question in England, including a brief account of the special tribunals which have been established to determine disputes respecting the carriage of coal on railways and canals, followed by the leading points of cases which have been adjudicated by the Supreme and Appeal Courts, and the Railway and Canal Commissioners). Col Guard–July 3. Serial. 1st part. 3200 w.

*7040. Railway Companies and the Carriage of Coal (A copy of the circular issued by the Midland, Great Northern and London and North-Western railway companies on the subject of charges for the conveyance of coal, with action taken by the Coalowners' Assn). Col Guard–July 3. 600 w.

*7041. The Hungarian National Exhibition (A description of the interesting mining exhibit). Col Guard–July 3. 2500 w.

*7042. Precautions Necessary in the Use of Electricity in Coal Mines. H. W. Ravenshaw (Read before the Federated Inst. of Min. Engs. A few suggestions the carrying out of which may serve to minimize the risk both from shock and fire). Col Guard–July 3. 3000 w.

7091. Uniform Methods of Testing Iron and Steel (Summary prepared by Henry B. Sea-

man, of the recommendations of the committee of Am. Soc. of Civ. Engs. as given in their general report). Eng News–July 16. 1800 w.

*7124. Baku and Its Oil Industry. W. F. Hume (Interesting account of the rapid growth of the town due to its excellent harbor and the oil supply. Historical account of the growth of the naphtha industry, description of the wells and method of working, with other interesting information). Nature–July 9. 2400 w.

7127. The Geological Age of Gold. Dan De Quille (Concludes that gold bearing veins have been formed in all ages, but locally at different times). Eng & Min Jour–July 18. 1600 w.

7142. A Special Hydraulic Coal Tipper at Ruhrort (Illustrated description. The excess of power furnished at the time of filling is utilized to raise the empty truck). Am Mfr & Ir Wld–July 17. 300 w.

7143. Nitrogen in Coal. William Foulis (Abstract of address before the Incorporated Institution of Gas Engineers. Suggestions pointing out the direction in which further investigations may be made to recover the greater portion of the nitrogen now lost in the coke). Am Mfr & Ir Wld–July 17. 1400 w.

7144. Coke Production in 1895. Jos. D. Weeks (Extract from report made to the United States Geological Survey. Shows the production outside of the Appalachian region is a growing one). Am Mfr & Ir Wld–July 17. 1500 w.

†7153. The Petroleum Industry in Japan (Editorial on the value of the oil industry in Japan and the effects on the markets of China and India). Ind Engng–June 13. 600 w.

*7163. Coaldust and Explosives. H. Richardson Hewitt (Abstract of a lecture before a meeting of undermanagers and deputies of the Gresley and Coalville districts. History of the subject, with opinions of the writer). Col Guard–July 10. 2800 w.

†7166. Report on Indian Coals (Letter to the editor quoting from report by Sir Frederick Abel). Ind Engng–June 20. 350 w.

7255. Sepiolite. R. Helmhacker (Description of formation, locating deposits, and qualities of this mineral). Eng & Min Jour–July 25. 2000 w.

*7257. The Coal Owners and the Wages Question (Statement of Thomas Ratcliffe Ellis, secretary to the Federated Coal Owners, with regard to the present position of the wages question in the coal trade). Col Guard–July 17. 2800 w.

*7258. Electrical Haulage at a German Colliery. Herr Koepe, *Zeitschrift des Vereins deutscher Ingenieure* (Description of the installation at the Ewald pit, near Herten). Col Guard–July 17. 1200 w.

*7259. Afterdamp. T. Getrych Davies (Read before the So. Wales Inst. of Engs. The writer's experience in dealing with the gases met with after colliery explosions). Col Guard–July 17. 2000 w.

†7263. Brazil: Minerals, Mining, etc., of the State of Bahia (Report of consul on the minerals and metals of this region). Cons Repts–July. 1600 w.

*7287. Dr. Haldane on Carbon Monoxide Poisoning (Reference made by Frank Clowes to the work of Dr. John Haldane, with extracts from his report on "The Causes of Death in Colliery Explosions, etc"). Jour of Gas Lgt–July 14. 2200 w.

*7291. Petroleum (Where found, how obtained, and the manner of using it, with illustrations). Mach, Lond–July 15. 1800 w.

†7323. Faulting and Accompanying Features Observed in Glacial Gravel and Sand in Southern Michigan. Carl Henrich (Interesting geological features, with a possible explanation of the cause). Trans Am Inst of Min Engs–July. 1300 w.

†7324. Vein-Walls. T. A. Rickard (Interesting study of the subject with many illustrations). Trans Am Inst of Min Engs–July. 12000 w.

†7330. Rapid Section Work in Horizontal Rocks. Marius R. Campbell (A new system introduced by the writer which has met with general approval). Trans Am Inst of Min Engs–July. 5400 w.

†7331. Gold in Granite and Plutonic Rocks. William P. Blake (Examples showing that we must recognize such rocks as truly gold bearing). Trans Am Inst of Min Engs–July. 2800 w.

*7434. Explosive Mixtures of Combustible Gases with Air. Frank Clowes (Summary of a lecture delivered at the Gas Inst. Deals with the explosion of combustible gases and the limits; poisonous constituent in coal gas, gaseous fuel, and in the products of their incomplete conbustion; detection and measurement of carbonic oxide, etc). Col Guard–July 24. 2800 w.

*7494. The New South Wales Coast. Joseph E. Carne (Its geology and mineral resources). Aust Min Stand–July 9. 2000 w.

7502. The Occurrence of Platinum in New South Wales. J. B. Jaquet (Abstract of reports. Account of discovery and work). Eng & Min Jour–Aug. 8. 900 w.

7503. The Mineral Fuels of Manitoba and the North West Territories. William Pearce (A subject of interest to settlers as a portion of the country is to a large extent a treeless plain. Coal, natural gas and petroleum have been found). Eng & Min Jour–Aug. 8. 2200 w.

7505. Some Minerals Found in the Republic of Guatemala. John Rice Chandler (List of minerals with location and brief description). Eng & Min Jour–Aug. 8. 1000 w.

*7512. The Rate of Increase of Temperature with the Depth of Subterranean Operations (Notes of investigations and experiments on the subject). Col Guard–July 31. Serial. 1st part. 1400 w.

7533. Brookwood Coal Washer. F. M. Jackson (Read before the annual meeting of the Alabama Industrial and Scientific Society. Describes and illustrates the washer in successful operation by the Standard Coal Co., of Brookwood, Ala). Am Mfr & Ir Wld–Aug. 7. 1200 w.

MUNICIPAL ENGINEERING

Effects of Steam Road-Rolling on Gas and Water Mains.

IN this department of our May number a paper upon the effects of steam road-rolling read by Mr. H. Humphreys before the Institute of Civil Engineers was reviewed. The subject was again taken up for discussion before the Association of Municipal and County Engineers at Brighton, England. The injury resulting to drains and pipes was admitted, and the following rules for putting down drains and mains, adopted in Nottinghamshire, were read by one of the members:

"When road material or foundation is taken out, it shall be properly sorted, and any portion that may be soft or wet shall be entirely removed from the roads. The trench shall be re-filled with as much of the dry material as the county surveyor shall consider fit for the purpose: provided always that the foundation of the road shall be made up with four inches of hard dry core, cinders, or rammel, with a final coat, four inches thick, of new, good, sound metalling, similar in character to that of the existing road. As each layer of the new filling-in and road surface is made, it shall be thoroughly well rammed. Should any unevenness afterwards occur, the road surface shall be made good with approved sound road material. Pipes and drains laid beneath any road under the jurisdiction of the county council shall, if within three feet of the surface of the road, be covered with at least six inches of concrete surrounding the pipes or drains, or the pipes or drains shall be constructed of iron. It must be clearly understood that all pipes and drains shall be laid so as to permit a steam-roller to be used at any time over the same; and the council shall be held free, in case of any accident happening to the pipes or drains—the cost of re-instating any pipe or drain that may be broken or damaged being borne by the authority, company, or persons laying or owning the pipes or drains."

The gentleman who brought these rules to the notice of the meeting said that such pipes and mains as had been injured in Nottinghamshire have usually been those that required abolishing by reason of their bad condition.

Another member complained of the difficult position in which engineers were placed with reference to damages. Anyone using a steam-roller was liable for the damage done by that roller to gas or water mains, unless he could prove that the pipe damaged had been improperly laid. This was a very difficult thing to do. If the company gave evidence to the effect that the pipe was properly laid, it was a very hard matter for the local authority to prove it was otherwise. What he apprehended was that some day or other there would be a serious catastrophe. There would be a leakage of gas, resulting from a fracture of the mains, which would blow up two or three houses, and cause several deaths; and there would be a big bill to pay. Then this question of liability would be brought before them in a very unpleasant way.

Another member, who had been compelled to quit using a fifteen-ton roller and substitute for it a ten-ton roller by the action of a gas company which feared injury to its mains, said he had obtained nearly or quite as good results by the use of the ten-ton roller, leaving it to be inferred that the use of heavier rollers was not necessary. He also asserted that the ten-ton roller did just as much work as the fifteen-ton roller. Another member fully agreed with this statement, as the result of his experience. It appears from this discussion that the use of the fifteen-ton rollers is being discontinued by some engineers, except in making roads under which there are no pipes. One member recounted his experience with the heavy roller, from the use of which an explosion of gas resulted, and said that since that time the use of a roller weighing more than

ten tons has been prohibited in Brighton, except in suburbs where there are no underground pipes to be injured.

A New Setting for Gas Retorts.

THIS new system of setting retorts has been discussed in various journals devoted to the gas industry, and all seem to concede that it is another stride in the progress of the art. *The Engineer* (June 5) has published an illustrated description, which we draw upon for this review.

The new setting obviates any interruption of fires or accidents to firemen that may occur in drawing the red hot coke from the retorts into the coke-hole, and effects a considerable saving in labor and in space now required for shovelling back the quenched coke towards the walls of the house. This handling of the coal breaks it up more or less into breeze; hence more of the coke is retained in good condition by the avoidance of the shovelling alluded to.

The first setting of this sort was built at the East Greenwich works of the South Metropolitan Company, England, at which works the method has had a trial during the past winter and present summer, and, it is said, has achieved unqualified success.

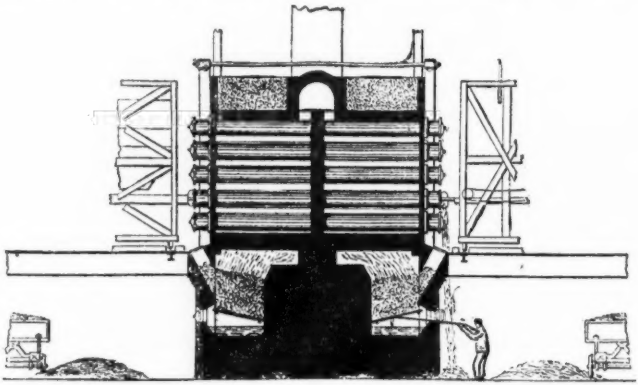
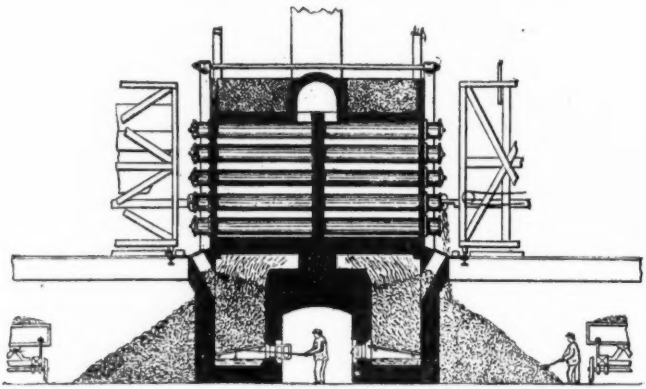


Fig 1.



JOYCE'S GAS RETORT SETTING

The accompanying engravings illustrate the description.

Instead of making the bench solid, as shown in Fig. 1,—the old way,—"The system consists, as shown in Fig. 2, in

forming a tunnel in the middle of the retort bench, extending throughout its length, and on a level with the floor of the ovens. The doors of the furnaces on both sides of the bench open on to this tunnel, and the clinkering and raking of the fires are done from it. The fuel is fed into the generator at a mouthpiece on the stage-level, but in all other respects the furnaces are in effect reversed, and the faces of the stack below the stage are unbroken by doors or dampers. The firemen do not enter the coke-hole, and its capacity for coke storage is much increased. The coke is quenched and loaded direct into the wagons without previous handling. The firemen working in the tunnel are not interrupted by the drawing of the retorts, and thus a saving of labor is effected, while the furnaces are accessible for inspection at all times. In constructing a bed on the tunnel system there is a saving of bricks, as the solid mass of brickwork in the middle of the bench is considerably diminished. It is claimed for the system that in one year it effects a saving more than sufficient to compensate for the outlay of converting existing benches to it. The South Metropolitan Gas Company have been so well pleased with the working of the experimental bed that they have now nearly completed the work of converting the beds in all their retort-houses at East Greenwich to the new system. The benches and system of firing at that works were very favorable to the conversion, and undoubtedly a great economy has been effected.

"In other cases, as when a flue runs the length of a stack in the position required by the tunnel, greater but not insuperable difficulties would be offered to the work of conversion. The coke-hole space at East Greenwich is very cramped, and no doubt the make of breeze under the old system of working was greater there than it is at many works, and for the same reason fatal accidents to firemen appear to have been of more than common frequency there. But in houses where the coke-hole is of ample width we have witnessed bad accidents to firemen from the falling coke and tar, and, as a preventive of these, Joyce's tunnelled beds are to be commended. In these same wide retort-houses, too, the labor expended in shovelling back the coke from the face of the stack towards the wagons is immense, and therefore the dictates of economy would favor the adoption of the tunnelled retort beds. When the system is being introduced in a new setting, several minor improvements may be made, such as shoots from the top of the stack into the tunnel, which save much labor with the wheelbarrow. Some settings now in course of construction at the East Greenwich works will have this useful addition to the tunnelled retort beds."

In conclusion, *The Engineer* expresses the belief that this is one of the most valuable improvements in retort houses which has been produced in recent years.

How Water Meters Should Be Set.

FROM a report of a committee of the American Water Works Association rendered at the recent Indianapolis meeting of that body, the following summary of the principal essentials is prepared.

The plan of placing meters in cellars, while presenting the advantage of protecting them from frost, is objectionable on account of inaccessibility when tenants are absent, the danger to inspectors of the attacks of vicious dogs, etc. Setting meters in pits in side-walks or yards in cold climates is also objectionable, though in warm climates it is not so, the inconvenience of uncovering the pits from snow and ice being the principal objection to this position. From careful consideration of the facts the committee arrived at the conclusion that no position that will be generally applicable can be fixed upon. The recommendation is made, however, that all meters be set either by the water departments or under their immediate supervision. Each water department should endeavor to have all its meters set in a uniform manner. This will be found to aid greatly in removing, repairing, and reading. The inlet and outlet of meters should be plugged up before being shipped, to prevent foreign matter from accumulating in them. They should be thoroughly blown out and subjected to a bench-

test under varying deliveries before being set. They should in all cases be set level, when possible, and should also have strainers attached to the pipe connection. The size and kind of meter for each service should always be specified by the water departments. Meters supplying steam boilers should have a check-valve placed between the meter and the boiler, provided, however, the boiler is equipped with a safety valve. If this precaution is not taken, serious consequences are likely to ensue. In all cases a stop and waste-cock should be placed between the meter and street main; also a stop-cock between the meter and riser, or services. This will be found a great advantage in removing and testing meters, and will more than repay the additional outlay. No lead of any kind should be used in making joints.

When meters are set in cellars, they should be placed as near the wall as possible, and they should also be accessible for light repairing, removal, and inspection. When there is danger from frost, the meter should be encased in a wooden box of suitable size, with a hinged cover, and packed around with sawdust, mineral wool, or other non-conducting material. When meters are placed in sidewalks or yards, they should be set in either a brick pit or an iron or wooden box, which should be of such size as to allow of its removal without disturbing the box. The pit or box should have an iron cover (preferably hinged) with some locking device, to prevent tampering and depredations. The meter should be set at such a depth as to prevent freezing, and, if necessary, packed around with sawdust or other suitable material. In extreme cases it would be advisable to construct the pit with a false bottom and fill above this with sawdust. The question of material for the box or pits is one to be decided according to circumstances, remembering, however, that brick and iron ones are more economical in the long run. In setting meters in the sidewalk, the meter should be placed about eighteen inches inside of the curb, and under no circumstances be nearer the wall of building than two feet. In setting in any of these positions described, the meter should always be equipped with the cocks, etc., above named.

An Illustration of the Utility of Water Meters.

EDITORIALLY *The Engineering Record* calls attention to the experience of the municipal government of Richmond, Va., in an abstract of a report for 1895, of Mr. Charles Bolling, superintendent of the water-works of that city, and cites this experience as an illustration of the economy which results from the employment of water-meters. One of the incidents connected with the use of meters is as follows:

"The Chesapeake & Ohio Railway has a tank supplied from the city mains. In July last 2,428,900 gallons passed through the meter, making the bill for the month $170.02. The company promptly objected to the amount of the bill. Upon examination, a large hole was discovered in the pipe leading from the tank, and through this water was flowing to an underground drain. This was repaired, and the bill for August was $34.30. Had there been no meter there, the leak would not have been discovered, and the city would have lost $1,508 worth of water in one year.

"In 1894 651 meters were set, and the pumpage for that year was 1,000,000 gallons per day less than in 1893. In 1895 282 meters were added, and the pumpage was 500,000 gallons per day less than in 1894. That is, although 875 taps had been added in these two years, the quantity of water pumped was reduced 1,500,000 gallons per day. Nearly all these meters have been set in the higher portion of the city. Had they been set in the lower portion of the city, where the pressure is greatest, the saving would probably have been greater. As it is, an improvement in the pressure at several of the high points is already noticeable."

The editorial reviewed makes a point not noticed in Mr. Bolling's report,—to wit, that "such leaks as he describes not only cost the city for the water lost, but lead to a demand for expensive additions to water-works before they are actually needed or can be afforded."

A committee of investigation, to consider and report upon the average consumption *per capita* in Richmond, reported that the consumption averaged 126 gallons per head, of which only five per cent. is metered. "The committee estimated that 60 gallons daily would be a proper *per capita* allowance for a city as far south as Richmond, and recommended that meters be introduced to reduce the consumption to this figure, in preference to increasing the capacity of the works. As the present capacity of the works is 12,000,000 gallons daily and the population 95,000, it will be seen that the population of Richmond could be doubled before an enlargement of the works would be needed, if the waste of water was checked as recommended, and that there would seem to be no need of burdening the citizens of Richmond with the expense of enlarged works that more properly should be borne by the next generation." Perhaps no better example of the salutary effect of meters in preventing careless and wanton waste of water could have been selected, than this.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Municipal Engineering in the American, English, and British Colonial Engineering and Municipal Journals—See Introductory.

Gas Supply

*6985. The Important Future of Producer-Gas. Ill. A. Humboldt Sexton (Showing the advantages of gaseous fuel and the various methods of producing it). Eng Mag-Aug. 4200 w.

7032. Acelytene Gas. George Black (A general essay, historical and descriptive). Can Elec News-July. 3800 w.

7115. Prepayment Meters. M. Van der Horst (Three months' experience with these meters in Utrecht, Holland). Pro Age-July 15. 1800 w.

7423. The Wrecking of Holder No. 1, Station C, of the Laclede Gas Company During the Recent Cyclone at St. Louis, Mo. D. L. Hough (Profusely illustrated description). Pro Age-Aug. 1. 800 w.

*7424. Some Labor-Saving Methods in Photometrical Testing. Henry O'Connor (Read at the annual meeting of the North British Assn. of Gas Managers. The use of the graphic method in photometrical work, and the substitution of mechanical means for this method. Also discussion). Gas Wld-July 25. 3000 w.

*7425. The Permanency of Illuminating Gas. William Young (Read before the N. Brit. Assn. of Gas Managers. The effect of vapor tension and absorption of illuminating constituents by oil, modifications of permanency, etc). Gas Wld-July 25. 6800 w.

†7457. The Welsbach and Other Incandescent Gas Lights. George S. Barrows (Descriptions of fair examples of this large family of gas-lights, and a description of the process of manufacture of the Welsbach light at Gloucester. Discussion). Pro Eng's Club of Phila-July. 3000 w.

Sewerage.

†7061. Which Should Have the Steeper Grade, Main Drain or Laterals? (A general discussion). Ill Soc of Engs & Surv-11 An Rept. 1800 w.

7107. Surface Drainage of Suburbs (Abstract of a report (1895) by Bertrand T. Wheeler, Supt. of Streets, Boston, Mass.). Eng Rec-July 18. 1200 w.

7284. The Providence Sewer Tunnel (Illustrated description). Eng Rec-July 25. 600 w.

*7408. Intercepting and Relief Sewers. Charles Carroll Brown (The object of the writer is to show that the principles of intercepting and relief sewers can often be applied with advantage to the sewer system of small cities). Munic Engng-Aug. 1500 w.

Streets and Pavements.

*7176. How to Lay "Cement" Street Paving (Plain practical directions for paving, with illustrations of kinds of work, description and cuts of tools). Ill Car & Build-July 10. 1700 w.

Water Supply.

7020. The Cold Spring, N. Y., Concrete Dam (An illustrated description of some interesting features of a system of water-works just being completed at place named). Eng Rec-July 11. 1300 w.

†7055. A Novel Test of the Flow of an Artesian Well. W. D. Peace (Water bearing stratum reached at 700 feet below surface. Tests were made for determining head as well as flow). Ill Soc of Engs & Surv-11th An Rept. 2200 w.

7088. A Small Asphalt-Lined Reservoir at Indio, Cal. J. B. Lippincott (Description. Composition of the asphalt concrete. Experience and general remarks). Eng News-July 16. 600 w.

7105. The Galveston Water-Works (Illustrated description. Part first contains history of development and investigation, map and profile, proposed and adopted location of wells, designed and constructed standpipe, suction well, determination of size of conduit and analysis of engine requirements). Eng Rec-July 18. Serial. 1st part. 2500 w.

7129. Laying Water Mains. J. H. Decker (Common sense remarks and suggestions). Fire & Water-July 18. 1800 w.

We supply copies of these articles. See introductory.

7282. Some of the Factors Which Determine the Efficiency of Filters for Water Purification. James H. Fuertes (Description of European methods of solving the problem of efficiency. Theoretical considerations affecting the question systematically presented, in connection with actual mechanisms employed). Eng Rec-July 25. Serial. 1st part. 2800 w.

7283. The Fort Field Reservoir, Yonkers, N. Y. (Illustrated description). Eng Rec-July 25. 800 w.

7288. Report of Committee on Best Methods of Setting Meters (Presented to the convention of the American Water Works Assn. at Indianapolis. Deals with the practical details of position, size, etc., of water meters for different services). Fire & Water-July 25. 900 w.

†7310. The Purification of Public Water Supplies. George H. Rohe (Address delivered at the meeting of the American Medical Assn. at Atlanta, Ga. A general review of the subject in its relation to public sanitation, and the prevention of epidemic diseases). San-July. 3000 w.

7365. Some Facts about Slow Sand Filtration of Water. Mrs. Percy Frankland (The fluctuations in the quality of filtered water as indicated by systematic bacterial examinations are noted, with conspicuous examples; and while efficient filtration is of the highest sanitary importance, it is shown that this does not render us independent of the nature of a water supply). Eng News-July 30. 1300 w.

7370. Flowage Test of a 14-in. Riveted Steel Main at New Westminster, B. C. A. McL. Hawks (Description of pipe and of tests). Eng News July 30. 2000 w.

†7388. Schönheyder's Positive Water-Meter (Illustrated description of a new form of this meter brought out in 1895). Ind & East Eng-July 4. 1400 w.

*7413. Water Supply (Editorial. General considerations relating to features of municipal engineering practice and apportionment of water rates). Engng-July 24. 1400 w.

7415. Evolutions of Water Supplies. J. T. Fanning (Abstract of a paper delivered before the Indianapolis convention of the Am. Water Works Assn. Some interesting facts). Eng Rec-Aug. 1. 1200 w.

†7458. The Water Supply of Rome. Henry Leffmann (Description of ancient water works of Rome, compiled from a variety of sources which the author names, and which form a sort of bibliography of the subject). Pro Eng's Club of Phila-July. 3500 w.

7482. The Water Supply for San Diego, Cal. (The steps taken toward municipal ownership of the water-works. The developing the supply includes a rock fill dam with an asphalt face 3100 ft. above the sea, and some 50 miles of conduit). Eng News-Aug. 6. 700 w.

7508. The New Arched Dam at Nashua, N. H. (Illustrated description of the new dam of the Pennichuck Water-Works Co, of Nashua, N. H). Eng Rec-Aug. 8. 1100 w.

*7555. Masonry Dams, Remscheid and Chemnitz Water Works (Illustrated description). Eng, Lond-July 31. 900 w.

*7557. Discharge Tunnels from Reservoirs. James A. Paskin (Points in construction that demand special attention under special conditions). Eng, Lond-July 31. 2200 w.

Miscellany.

7018. Garbage Cremation in Europe. James H. Fuertes (Describes cremation as the author personally saw it carried out in the city of Hamburg, and also in Leeds, Eng., with some experimental data). Eng Rec-July 11. 2300 w.

†7052. The Disposal of Garbage. Charles S. Hill (Considers this a new and important field for engineering effort, and discusses its general features). Ill Soc of Engrs & Surv-11 An Rept. 3500 w.

†7056. Tests of a Vitrified Earthenware Water Conduit. Dabner H. Maury, Jr. (The pipes were 24" diameter. The construction of the conduit is described, the nature of the tests explained, and extensive table of data is presented, with discussion). Ill Soc of Engs & Surv-11 An Rept. 4500 w.

†7057. Sanitary Engineering and State Boards of Health. Jacob A. Harman (Review of work done by State boards of health, with discussion). Ill Soc of Engs & Surv-11 An Rept. 6500 w.

7106. Final Disposition of the Wastes of New York City (Extended abstract of a report by George E. Waring, Jr., Commissioner of Street Cleaning of New York). Eng Rec-July 18. 2000 w.

7111. A Fabric of Misstatements (Editorial criticism of the paper entitled "The Municipal Ownership of Gas Plants" read before the recent New Haven street-lighting convention). Pro Age-July 15. 3000 w.

7112. The Reply of Houston, Kennelly and Kinnicutt, to Criticisms on the Progressive Age Report, Concerning the Cost of the Carbide of Calcium (Editorial comment). Pro Age-July 15. 700 w.

7113. Reply of Progressive Age Commissioners to Criticisms on the Cost of the Carbide of Calcium (In this reply the various criticisms and allegations which have appeared in different papers and which tend to throw doubt upon the validity of the conclusions arrived at by the commissioners, are met seriatim, and supplemented by press comments upon the work of the commissioners). Pro Age-July 15. 3000 w.

7114. Standards of Light. Edward L. Nichols, Clayton H. Sharpe, and Charles P. Matthews (Preliminary report of the sub-committee of the Am Inst. of Elec. Engs., presented at the general meeting, New York, May 20, 1896). Pro Age-July 15. 4500 w.

†7309. More About the Public Rain Baths. Moreau Morris (Read at the Conference of Charities, New York. Historical sketch of the attempts that have been made to establish free public baths in New York city, of which the public rain baths are the latest phase). San-July. 5600 w.

RAILROADING

Articles of interest to railroad men will also be found in the departments of Civil Engineering, Electricity, and Mechanical Engineering.

The Prolonged Era of Economy.

THE extent to which rigid retrenchment and reduction of expense still prevail in the administration of railroad affairs generally throughout the country is well illustrated in the statistics just published by the interstate commerce commission, abstracted from the eighth statistical report of that body. True, there are signs here and there of a feeling of greater financial freedom, but these are not numerous or important enough to affect much the general impression.

The year's increase of mileage was lower than ever before, even in 1894, being but 1,948.92 miles, or 1.09 per cent. Fourteen roads were abandoned, 9 merged, 32 reorganized, and 28 consolidated, none of which processes suggest financial expansion.

The increase in number of locomotives in service was but 207,—not an adequate proportion even to the small increase in mileage; the cars of all classes in service actually decreased 7,517, and in freight-cars alone the decrease was 9,050, though this is partially due to the increase of non-reporting private line equipment.

The total number of employees was slightly increased, being 785,934 on June 30, 1895, or 5,426 more than at the corresponding date last year; but the increase appears to have been in maintenance of way and maintenance of equipment, and some other departments where economy has over-reached its limit; in five groups of employees there was a decrease.

It is not surprising to find that the same reluctance to incur any expense appears again with marked effect in the figures of train-brake and automatic-coupler equipment. Out of a total of 1,306,260 locomotives and cars, only 362,498 were fitted with train-brakes, and 408,856 with automatic couplers, on June 30, 1895, the additions for twelve months being but 31,506 as to train-brakes and 51,235 as to couplers, the deficiency being especially noticeable in the locomotives in freight service.

When the statistics of operation and of finance are examined, the reasons for the minimizing of expenditure are readily apparent. Freight-tonnage, indeed, increased about 8 per cent., the total number of tons carried being 696,761,171; but the haul was, in the average, shorter, and the number of tons carried one mile (85,227,515,891) was but 5.74 per cent. greater than in 1894. Passenger business, on the other hand, showed a marked decline, 507,421,362 passengers being carried altogether,—33,266,837, or about 6.5 per cent., less than in 1894; but the passengers carried one mile were about 16 per cent. less than in the preceding year. As a net result, passenger revenue decreased 11.6 per cent., and freight receipts increased only 4.36 per cent.

The ratio of operating expenses to operating income, which in 1894 was 65.80 per cent., in 1895 was 67.48 per cent. The total income from operation was somewhat greater than in 1894, but the increase was more than wiped out by the decrease in income from investments and other sources, and the railways of the United States closed the year with a deficit from the year's operations of "$29,845,241, which was met by a decrease in accumulated surplus, or by the creation of current liabilities."

Stock to the amount of "$3,475,640,203, or 70.05 per cent. of the total outstanding, paid no dividend, and $904,436,200, or 16.90 per cent. of funded debt, exclusive of equipment trust obligations, paid no interest during the year covered by the report." And, "of the stock paying dividends, 6.89 per cent. of the total stock outstanding paid from 4 to 5 per cent.; 5.39 per cent. of this stock paid from 5 to 6 per cent.; 4.41 per cent. paid from 6 to 7

per cent.; and 3.99 per cent. paid from 7 to 8 per cent. The average rate on all the dividend-paying stocks was but 5.74 per cent.; the average return on the entire railway stock capitalization of the country was about 1.74 per cent."

And now come the framers of the Chicago platform with a demand "for the enlargement of the powers of the interstate commerce commission, and such restrictions and guarantees in the control of railroads as will protect the people from robbery and oppression." From the report of the commission itself, it appears that robbery is a most unprofitable occupation, and the oppressor barely escapes from starving on his spoils.

American and British Permanent Way.

OUR highly esteemed contemporary, *The Engineer*, seems to be having a terrible time over the question of permanent way. Some of its unfeeling correspondents persist in urging "that American track is so much better" "that no time should be lost in discarding the English cross-sleeper and chain for the flanged rail and tie," and, as *The Engineer* holds "that the normal English road, with a 90-pound or, better still, a 100-pound rail, makes the best track in the world," this is very painful to its feelings, and necessitates repeated self-administration of editorial argument to neutralize the apparently highly disturbing effects of these suggestions.

However, having again attained a comfortable composure, which "will not concede for a moment" that English roads "have anything to learn from American practice," the present attack seems to be over, and the American roads at least have lost nothing thereby.

The curious thing is that, so far as can be discovered by a thorough examination of the exchanges, *The Engineer* is doing this furious battle solely against shadowy figures of the mist,—ghostly shapes of correspondents whose exasperating effect can hardly be explained, unless, indeed, like specters in the hands of the dramatist, they are the counterpart of certain uneasy operations of the mind, and merely embody with hideous concreteness vague suspicions which *The Engineer* would rather bury from its own sight in its own soil.

Imagine the *Railroad Gazette* coming out in every other issue with an elaborate argumentative defence of "American track;" and yet, as *The Engineer* remarks, "nothing like finality has been arrived at" on this side as to many details. But this evidences only the flexibility of the type,—a merit, not a defect or limitation.

As *The Engineer* has been allowed to have the discussion so completely to itself, it may interest some of those who do not see it to know how defective our product appears to an unsympathetic observer. The italics are ours. "When yellow pine or softer woods are used (for ties), it has been found *necessary* to interpose between the rail and the wood a large piece of boiler-plate."

Even with eighteen ties to the rail, "the roads are far from perfect; *very great difficulty* is experienced with the joints;" "one of the most serious objections to the flanged rail is that it is *next to impossible* to fish it satisfactorily."

It is "a road very difficult to repair, because the removal of a rail in practice means the destruction of the sleepers"; "the sleeper is virtually ruined by the extraction of the spikes, and we believe it is the practice on most, if not all, first-rate roads to put down new ties whenever rails are renewed." *The Engineer* is entirely misinformed. It is not the practice to do anything of the kind.

These renewals seem very alarming things: it might almost be inferred that the chief occupation along a railway line was taking up rails and relaying them. "A gang of plate-layers," we are told, "could replace a couple of lengths of rail before an American gang would get the spikes out." It would be interesting to see the test; but, after all, the more important consideration is to keep a good smooth track *down*.

Lastly, *The Engineer* finds a "mystery" in the reported failure of an experimental section of "normal" English track under American rolling-stock on the Pennsylvania railway.

"The speeds on the Pennsylvania Railway are not greater than those used on the London and North Western, Midland, and other first-class lines here. The loads carried per wheel are almost the same; rather heavier, we think, in this country than in the United States." * * * "And now we are told by one eminently qualified to make the statement that a first-class English road will not bear American rolling-stock." Some one should tell our doubting friends that American rolling-stock is very much heavier than English. The load of 18 tons per axle, which it cites as having been attained in English practice, is evidently in locomotive building; an equal weight per axle is not at all unusual in American engines.

Our heavier sleeping-cars are nearly or quite as heavy as a locomotive; and in total weight of trains, or in weight imposed per rail, there is no comparison.

The record-breaking train on the Lake Shore, by which (to quote *The Engineer's* still suspicious language) such "enormous speeds are said to have been attained," weighed about 225 tons,—just about the weight of an average English express train; but it was a very light train of three cars only. It is not at all unusual for through trains on our trunk lines to be made up of ten cars or more, six or seven of them being sleepers of the heaviest type, making a load of 500 tons behind the tender.

The English roads have not yet offered anything nearly approximating such weights as this; but the amusing surprise and satisfaction with which the "corridor-cars" on the east and west coast lines have been received may grow into a demand from the British travelling public for greater comfort, and inaugurate a revolution in favor of a nearer approach to American standards of car-building.

If this should practically transfer American rolling-stock to British roads, there is little doubt that the result of the Pennsylvania experiment will be repeated in England.

But *The Engineer* certainly is in a position exciting sympathy. It is very annoying to find facts obstinately antagonizing an *a priori* conclusion. The most comforting course is to discredit the facts, but such comfort is unfortunately transitory.

The Railway as an Exponent of Civilization.

THERE is something taking about this title; it has not, so far as we know, been seized upon by any railroad essayist, but it would furnish a fine text for a writer gifted with a broad and intimate knowledge of his subject and fired by a fine enthusiasm for its importance.

The railroad is classed, by many careful thinkers, as beyond all question the most powerful influence upon modern life in its broadest significance. For, beyond its potent effects on commerce, industry, and finance is the more important, if somewhat less tangible, force it has exerted on thought, education, social customs, and political conceptions. It has endowed the national body not only with more powerful and fully-developed muscles, but, far more than this, with a new and most highly developed nervous system, bringing every remote member into intimate connection with the great centers, and binding all together in a community of feeling and an interdependence of existence never before dreamed of. It overleaps geographical and political boundaries, tying nations together with bonds that can hardly be broken; for one word written on strategic lines of railway in war, there might be ten thousand for its continuous and well-nigh unbounded influence for peace.

As a southerner remarked to the writer some months since, standing on one of the crumbling earthworks near Nashville, from which rifle bullets and fragments of shell can yet be gathered after every rain: "If the railroads of 1860 had been like the railroads of 1896, these little difficulties could never have taken place."

The first effective taming of the wilderness comes just in the wake of the track-laying gangs; the notes of progress are sounded on the locomotive whistle, and the index of the industrial, the social, almost of the moral status of a country is to be found in its railway systems.

But just how this exponent is to be

written is harder to define, and the general equation which shall determine it for any given case apparently can not be determined, even from the elements given in the mileage statistics adapted by *The Railway Gazette* from the *Archiv für Eisenbahnwesen*. Taking the totals alone, as thus summarized:

North America	202,983 miles
Europe	152,417 "
Asia	26,078 "
South America	23,799 "
Australia	13,795 "
Africa	8,143 "

there is at once manifest a certain general relation which is in accordance with expectations, and, when we find that the United States alone has 179,297 miles of the total on the continent, it is very gratifying to our conviction that ours is the greatest and most enlightened country on the earth. But, when we compare relations of mileage to area, we fall suddenly and far from our proud position; we have but 6 miles of railroad to every 100 square miles of territory, while Belgium heads the list with 30.3, and Great Britain and Ireland comes second with 17.2, followed by Holland with 14, Switzerland with 13.7, Prussia with 12.4, France with 12.1, Denmark with 9.3, Italy with 8.2, and Austro-Hungary with 7.1. On this basis we have to be content with tenth place. It is some consolation to find that the other European States pull the general average down to 4 miles per 100 square miles, so that, compared with the continent as a whole, we still retain our supremacy.

If we take population as a basis, we are in much better case, for we have 26.2 miles for every 10,000 inhabitants, while Europe as a whole has but 4.1. True, Australia leads us with 32.4 miles, British North America and Newfoundland with 31.9, and the Orange Free State with 29.8. Even Argentina and Uruguay, with 19.1 and 14.9 respectively, are closer than we would have been willing to admit; but Great Britain with but 5.3, Belgium with 5.5, and France with 6.4 are hopelessly out of the race. Austro-Hungary (4.2) barely exceeds the average of all Europe, and even Sweden, with its leading figure of 11.8, is not within hearing of the eagle's scream.

The rear is brought up by Dutch India, with but .4 mile to 10,000 inhabitants, although close contestants for the "booby prize" are English India and Japan, with but .6 mile each.

A significant feature is the wide range of countries and districts brought into the circle of railroad influence, many of them most incongruously to our sense of association. Probably, before long, the man who goes down from Jerusalem to Jericho will go by rail, and, if report of Turkish roads be correct, will share the experience of the "certain man" who was in so sore need of the attentions of the Good Samaritan.

An Indian road, recently opened, expects to derive its revenue from pilgrim devotees to the shrine of Jaggernath. The Jungfrau is to be robbed of her coyness and inaccessibility.

The time is almost in sight when the pigmies of Africa, instead of hiding in impenetrable bush and greeting a Stanley with poisoned arrows, will lounge about the station platforms, spitting tobacco juice at the "schedule of commutation rates" of the Central African Trunk Line, and pestering the agent to know when the second section of No. 94 is coming along.

A Precaution as Bad as the Disaster.

A MOST deplorable instance of reckless daring, of misconceived execution of duty, and of a method of "testing" which provokes the disaster a proper means should avert, is furnished in the following paragraph from *The Railway Age*.

"A sad example of devotion to duty at the cost of life occurred on the Vandalia line near Crawfordsville, Ind., on the night of July 28. Roadmaster Brothers, fearing that the Walnut Fork bridge might be unsafe, ordered out an engine from Terre Haute to cross it for a test. Five men were on the engine which started across the bridge, and, when in the middle, forty feet above the raging river, the engine, without warning, plunged through the weakened structure into the river.

Three of the men were instantly killed, and the other two received injuries that may prove fatal. The killed are: Charles E. McKinzie, brakeman; R. B. Fowler, conductor; John Heiber, fireman. The injured are: J. S. Brothers, roadmaster, three ribs broken and otherwise injured; Frank Bowman, engineer, injured internally. A passenger train from Chicago was only ten minutes behind the ill-fated engine, and, had the roadmaster not ordered the testing of the bridge, the loss of life would undoubtedly have been great. The five railway men sacrificed themselves to save many."

It seems a most needless sacrifice, and respect for the bravery of the victims must temper, but cannot silence, criticism of the foolhardy act. Did the roadmaster conceive it his "duty" to devote himself and his companions to death, to wreck an engine, destroy a bridge, and tie up the traffic of the road, in order to prove the bridge unsafe?

If this is the best method of providing a "test" which is at the command of railroad officials, we had better throw experience to the dogs and burn our text-books. If nothing but absolute demonstration of the bridge's weakness, by testing to destruction, could prevent the passenger train from Chicago from crossing the structure, the engine might at least have been sent over alone, to the saving of agony to the dead and the living mourners.

No doubt the full expectation was that the bridge would stand; it is not conceivable that the roadmaster would have deliverately undertaken a course which he believed would destroy it; but it was his clear duty so to arrange his "test" that no disaster would have ensued, whatever the conditions which the test determined.

The Growth of the Trolley.

THE street-railway statistics of the United States, as compiled by the *Street Railway Journal*, display the rather remarkable extent (considering the comparative youth of the electric-railway system) to which the trolley has replaced all other forms of motive power for street-railway traction.

Out of a total of 14,470 miles of such railways in the United States, 12,113 are electrically equipped; the cable, a much older institution, is used on but 599. Dummy engines furnish the power on 519 miles, and 1,219, or a little over 8 per cent., still depend on horse power.

In Canada the proportional conversion to electric traction is even more complete,—450 miles out of a total of 462 use electricity. Indeed, any one guessing at the figures from preconceived opinion alone, without a knowledge of disturbing conditions in the shape of local legislation, would find many surprises.

The eastern States, for instance, have the largest mileage of horse-car lines of any group,—414 miles out of 4,634. New England retains but 88 miles out of 1,823, and the central States but 210 out of 4,600. The non-progressive appearance of the eastern States' figures is due to New York's 295 miles of horse-car lines out of 1,904 miles in the State. Pennsylvania, notwithstanding its proverbial reputation for staid conservatism, has but 10 miles of horse lines in a total of 1,491.

New York and Pennsylvania stand first and second in total mileage; Massachusetts, with 1,153 miles, is nearly tied for third place by Ohio with 1,135; Illinois comes fifth with 1,060,—hardly enough, one would think, for the suburbs of the great city to which the State is annexed.

At the foot of the list is Idaho, with 4 miles—but all electric; South Dakota stands second with 17; and Mississippi, with its much older settlement, can exhibit only 20.

A much better idea of the surrounding conditions is afforded by a comparative study of capital liabilities. The effect of expensive city construction is immediately manifest in the roads operating in densely-settled districts.

The roads of New York State, for example, have capital liabilities of $182,800 per mile, while in Florida the figures are but $7,000.

Taken in groups, the order is: the eastern States, with an average of $147,300 per mile of track; the central States, with $86,600; the western States, with

$61,100; New England, $54,500; and the southern States, $48,000.

The surprising thing, perhaps, is the position of the New England States as next to the lowest in capital liabilities. Massachusetts, which might be expected to raise its figures, is, in point of fact, surprisingly low,—only $52,300 per mile. Probably the explanation lies in the proportionately large mileage of track in small towns and along the highways between them.

British Influence in Chinese Railways.

THE IRON AND COAL TRADES REVIEW has recently published a good account of the beginning of railroad construction in China, with a description of the line from Tien-Tsin to Shang-Hai-Kuan, 177 miles long, the most important road now operated in that country.

It is built after British models, with rails rolled at Barrow; the engines, with the exception of one Grant locomotive, are English or Scotch; "American cast-iron wheels have been tried, but the steel-tired European wheels are preferred. All cars are equipped with Janney couplers, the only American detail in the rolling-stock."

And yet the *Review* seems to fear the loss or decrease of British influence. "What with Germans, Belgians, and Americans, all working hard to secure concessions, the English will only hold their own with the utmost care and diligence."

THE ENGINEERING INDEX—1896.

Current Leading Articles on Railway Affairs in the American, English and British Colonial Railroad and Engineering Journals—See Introductory.

*6980. First Principles in Railroad Signalling. Ill. George H. Paine (Describing in detail the various methods of interlocking and block-signalling). Eng Mag–Aug. 5200 w.

*6986. British Railway Stocks as Desirable Investments. William J. Stevens (Answering Mr. Thomas F. Woodlock's arguments against investment in English railroads). Eng Mag–Aug. 4700 w.

6999. Bridges for Electric Railroads. Charles F. Stowell (A review of accidents occurring under the new heavier requirements and an arraignment of inadequate specifications and defective tests). R R Gaz–July 10. 1500 w.

7000. Locomotive Records of the Illinois Central Railroad (A new method of classifying and charting repairs, showing the relation to mileage made and tabulating the condition of power on any division). R R Gaz–July 10. 2400 w.

7001. The Illinois Central Railroad Improvements at Chicago (Detailing the agreement between the railroads and the general plan of the proposed work). R R Gaz–July 10. 1700 w.

7002. Statistics of the Railroads of the World (Table giving milage of railroads of all countries, in proportion to area and population; and capital per mile for all important countries). R R Gaz–July 10. 300 w.

7003. Yard Limits (Editorial discussion of the necessity of adequate marks, rules and signals to remove the danger of occupying main tracks with yard work). R R Gaz–July 10. 1400 w.

7004. Demurrage on Freight Cars in England and America (A review of an English decision sustaining individual as opposed to average computation in levying demurrage on cars). R R Gaz–July 10. 900 w.

*7012. South Eastern Railway Engines: Past and Present. W. B. Paley (Historical review with many photographs of early English engines). Ry Wld–July. Serial. 2200 w.

*7013. Hartlepool Electric Tramways. (Decription of the line, power, installation and equipment). Ry Wld–July. 2300 w.

*7014. The New East Coast Corridor Trains (An enthusiastic description of an English approach to the American vestibuled train). Trans–July 3. 2400 w.

*7015. Maximum Legal Passenger Tariffs. London, Chatham and Dover Railway. (A tabular arrangement, with graphic representation of the main line and branches). Trans–July.

7029. Emergency Bridge Construction on the "Big Four" R. R. (Account of very rapid work in the temporary and permanent replacement of a wrecked bridge). Ry Rev–July 11. 1500 w.

7084. The Ithaca Street Railway (A description of a railway system in an ideal situation for the engineer who delights in difficult problems. It is considered a triumph for the electric system of traction). Elec Wld–July 18. 1700 w.

7085. Electric Lighting of Railway Trains in Australia. Daniel W. Maratta (Describing an installation of charging dynamo and storage cells, the method of running and the cost of maintenance). Elec Rev–July 15. 800 w.

*7086. Two Years' Extension and Working of Belgian Light Railways (Some general figures of mileage, capitalization, equipment and passenger and freight receipts). Eng, Lond–July 3. 3000 w.

7095. A Union Terminal for Chicago's Elevated Railways (History of the project, with maps and description of general method of using the loop line). Eng News–July 16. 1100 w.

We supply copies of these articles. See introductory.

7096. The New Fast Train Services Between London and Scotland. J. Pearson Pattinson (The service is stated to be remarkable for frequency and speed combined. A table accompanies the article). R R Gaz–July 17. 350 w.

7097. Jubilee of the London & North Western Railway. W. B. Paley (A sketch of the rise and progress of an important English line). R R Gaz–July 17. 1100 w.

7098. Railroad Matters in England. W. M. Acworth (Favorable opinion of the Glasgow Chamber of Commerce on pooling in England, and some notes on English baggage handling. R R Gaz–July 17. 1100 w.

*7099. Railway Block Signalling. J. Pigg (The first part is devoted to statement of some general principles, and the features of certain special signal codes, all based upon British practice). Elec Eng, Lond–July 3. Serial. 1st part. 1700 w.

*7100. Electric Traction: A Review of its Application and a Comparison with Other Methods. R. St. George Moore (A paper before the Inst. of Civ. Engs discussing traction, line and power from the civil engineers' point of view and by examination of prominent examples). Elec Eng, Lond–July 3. 2800 w.

*7117. Pringle and Kent's Surface Rail Electric Railway (Describing an English system proposed to replace the trolley, at a moderate increase of cost). Elec Rev, Lond–July 3. 2000 w.

7130. Discipline Without Suspensions (Results of the use of the Brown system of discipline on the K. C. F. S. & M. Ry. (The results described are highly favorable to the system, even under adverse circumstances). Ry Age–July 17. 900 w.

7131. Traveling Engineers or Road Foremen? (An argument for giving traveling engineers authority in the operating department). Ry Age–July 17. 800 w.

*7134. The Summer Train Services (An exposition of modern English passenger service as developed by the rivalry of the East and West Coast lines). Engng–July 10. 1600 w.

*7136. The Central London Railway (History of an underground electric traction line on which work is to be begun at once, with notes of other pending schemes). Eng, Lond–July 10. 1600 w.

*7139. American and British Permanent Way (Editorial, arguing the superiority of English practice). Eng, Lond–July 10. 1500 w.

*7140. Mechanical Fog Signalling (Editorial discussion of fog signal requirements and the respective merits of human and mechanical agencies). Eng, Lond–July 10. 1600 w.

*7145. Three Phase Electric Railway at Lugano, Switzerland (Reviews the advantages of the multiphase system and solutions of objections made, and gives a description of the first street railway built under the system). St Ry Rev–July 15. 2000 w.

*7146. Tests of Heavy Motor Cars on the Buffalo & Niagara Falls Electric Railway (Giving graphic representation of results of friction, traction, acceleration and electrical tests). St Ry Rev–July 15. 900 w.

*7147. An Important Pole Decision (Upholds an ordinance permitting the use of poles against the objection of an abutting property owner). St Ry Rev–July 15. 3000 w.

*7148. Paris Street Railway Notes. Charles N. King (The notes are concerned chiefly with the working of compressed air and steam (Serpollet) motors). St Ry Rev–July 15. 1500 w.

*7149. The Washington, Alexandria & Mt. Vernon Electric Railway (Describes a device for changing from underground to overhead trolley). St Ry Rev–July 15. 600 w.

†7158. Light Railways (A review of Mr. R. J. Money's paper before the Inst. of Civ Engs. is made the basis of a discussion of gauge, favorable to the retention of standard gauge, or to slight reduction only). Ind Eng–June 6. 1100 w.

*7159. Electrical Locomotives — Systéme Heilman (A sharp criticism of the engineering conceptions embodied in the construction). Elec Rev, Lond–July 10. 700 w.

*7161. Traction Diagrams. Thomas Tomlinson (The first part criticises the general insufficiency of data accompanying traction diagrams, and discusses such diagrams from the points of production, interpretation and utility). Elec Rev, Lond–July. Serial. 1st part. 2000 w.

†7164. Mexico: Tehuantepec Railway and Vera Cruz Harbor Works (Historical sketch of the undertaking and announcement of an important new contract for its completion and operation). Ind & East Eng–June 20. 2500 w.

†7165. The Siberian Railway (Sketch of the route, engineering features and progress of work on the line). Ind & East Eng–June 20. 1700 w.

7181. Development of the Railroad Facilities of New Orleans, and the Proposed Double Track Railroad Bridge over the Mississippi River. E. L. Corthell (Reviews the expansion of commerce in New Orleans consequent upon Ead's work, and the necessity for railroad facilities in proportion, and sketches the bridge project). Mfrs' Rec–July 17. 5500 w.

7183. Illinois Central Railroad (Historical and descriptive account of the road and its territorial relations). Mfrs' Rec–July 17. 5800 w.

7196. Street Railway Repair Accounts. C. F. Uebelacker (Advocates and illustrates a system of records designed to secure economy and increase efficiency in repair department). Elec Wld–June 25. 2000 w.

7197. Powers Over Street Railways. R. D. Fisher (A discussion of franchise limitations and municipal rights of control, and a plea for the simplification of street railway law). Elec Wld–July 25. 800 w.

7206. Automatic Signals on the Boston and Albany. George W. Blodgett (Describing the initiation and gradual development of a comprehensive system, with general considerations on the choice of a system and the incalculable value of signalling). R R Gaz–July 24. 2000 w.

7207. The Minimum Dimensions of a Rail

(Results of tests showing that the least thickness ever given to webs in practice is much more than sufficient to safely stand the strains and shocks of railway service). R R Gaz–July 24. 800 w.

7208. Municipal Ownership of Street Railroads (Abstracts of speeches by Charles Richardson favoring, and by Frank M. Loomis opposing ownership, both delivered before the National Municipal League of Baltimore). R R Gaz–July 24. 2300 w.

7211. Train Accidents in the United States in June (Classified table with explanatory comment). R R Gaz–July 24. 2200 w.

7212. Track Laying in the First Six Months of 1896 (A detailed statement by states and railroads). R R Gaz–July 24. 1200 w.

7219. Railroads and Bridges (Reviews the rapidity and proportions of the growth of the railroad in America, the daring engineering in its development, etc. Illustrates and describes noted railroad bridges crossing rivers, ravines and canyons). Sci Am–July 25. 3200 w.

7226. The American Locomotive (Historical sketch of its development since 1829, with photographs of typical engines). Sci Am–July 25. 2000 w.

7240. Rules for Loading Long Structural Material on Railway Cars (Report of committee of Master Car Builders' Assn., submitted to letter-ballot for adoption. The methods are illustrated by diagrams). Eng News–July 23. 3500 w.

7242. The Arrangement and Construction of Railway Shop Plants (Considers generally the location, arrangement, architecture, and equipment of buildings). Eng News–July 23. 2500 w.

7243. The Cubic Parabola as a Transition Curve for Street Railways. Jenks B. Jenkins (An example of its use as a solution of a difficult problem in Pittsburg, given to illustrate the practice, with formulas for determining minimum clearance in any curve and smallest radius to which the curve is applicable). Eng News–July 23. 500 w.

*7277. A New Electric Railway in the Isle of Man (Describes the line, construction and equipment of a scenic road). Elec Rev, Lond–July 17. 2000 w.

*7278. Trials of An Express Locomotive. William Adams and William Frank Pettigrew (Abstract minute of Pro. of Inst. of Civ. Engs. Giving the results of five tests of an English locomotive, with indicator diagrams and charting showing speed, boiler pressure, vacuum and air pressure, smoke box temperature and indicated horse power). Ind & Ir–July 17. 1700 w.

*7298. The New Train Services. Charles Rous-Marten (Describes with considerable detail, typical modern English fast-passenger service). Eng, Lond–July 17. 2500 w.

*7301. Gas-Motor Tram Cars (Illustrated description of these cars recently put in operation by the Blackpool, St. Anne's, and Lytham Tramways Co). Eng, Lond–July 17. 1000 w.

*7302. Locomotive Building in Japan (Facts about this engine, which was reported to have been constructed at much less cost than could have been possible in England). Eng, Lond–July 17. 1400 w.

*7341. Brazil Railways and Shipping (Contains data of lines operated, under construction, and projected, and of the unprofitable operation of existing railways). Trans–July 17. 500 w.

7342. Railroad Pooling. Martin A. Knapp (An address delivered before the Political Economy Club of the University of Chicago. The first part treats of the general relations of railways, the principles involved in pooling, and the abuses which would be checked by its influence). Ry Rev–July 25. Serial. 1st part. 4000 w.

7343. Traveling Engineers—Their Duties and What They May Accomplish. C. E. Slayten (Read before the North-west Railway Club. Discusses the work of the traveling engineer in great detail, and strongly recommends the extension of his authority with the operating department). Ry Rev–July 25. 2500 w.

7344. The Cost of Air Brake Rigging (Reviews the recent discussion arising from Mr. Parke's criticism of railroad shop expenses, and gives tabulated figures for a 36-ft. car rigging, with cost and weight, from actual practice). Ry Rev–July 25. 1200 w.

7345. Acetylene and Car Lighting. P. H. Conradson (Abstract of paper read before the North-west Railway Club. Reviews briefly the manufacture and use, and gives comparative illumination and cost of oil, carburetted air, Pintsch gas, electricity and acetylene). Ry Rev–July 25. 1800 w.

7371. Abstract of Statistics of the Railways of the United States for the Year ending June 30, 1895 (An advanced abstract of the forthcoming Eighth Annual Statistical Report, giving condensed statements of mileage, equipment, capitalization, earnings, expenses, etc). 2500 w.

7272. Freight Yard at Dresden, Germany (A noteworthy instance of time economy secured by proper laying-out and gravity switching, with some notes on sand track). R R Gaz–July 31. 800 w.

7374. Underground Electric Road in Budapest (Brief description of construction, operation, and equipment; with sectional drawings). R R Gaz–July 31. 700 w.

7375. The Logan Collision (Editorial reviewing the accident as an argument for the block system). R R Gaz–July 31. 1600 w.

†7378. The System of the Consolidated Traction Company of New Jersey (A full detailed description of power plant, equipment, permanent way, operation and discipline: with complete data, illustrations, table, map of the lines, etc. Also editorial). St Ry Jour–Aug. 7000 w.

†7379. The Electric Railway System of Rouen (A brief summary of the system and equipment). St Ry Jour–Aug. 500 w.

†7380. Some of the Rights of Street Railways in the Highway (A tabulated summary of decisions in questions of franchise, liability for accidents, etc). St Ry Jour–Aug. 2000 w.

†7381. Recent Electrical Overhead Work in San Francisco. S. L. Foster (The work is

notable for substantial construction and generous dimensions). St Ry Jour–Aug. 1800 w.

†7382. Car Specifications (Standard specifications of Consolidated Traction Co. of New Jersey for 20-ft. box cars). St Ry Jour–Aug. 1800 w.

†7383 Statistics of Mileage, Cars and Capitalization of American Street Railway Properties (The statistics are given in very clear tabulated form, with brief comment). St Ry Jour–Aug. 1000 w.

*7385. The Preservation, Maintenance and Probable Durability of Rolling Stock with Metal Underframes and Metal Upperframes. M. L. Tower (Translated from the *Revue Générale des Chemins de Fer*. Describes a most careful investigation of the wear and corrosion in cars built since 1861. Metal upperframes are not found to increase the life of the car. The metal underframes are given a life of 50 to 60 yrs. With editorial). Am Eng & R R Jour–Aug. 5000 w.

7391. A Right Way and a Wrong Way to Place Compressed Air in Competition with Electric Power for Street Railways. R. A. Parke (Discusses economy in compressing and criticises strongly the effort to secure long mileage between changings, by using very high storage pressures). W Elec–Aug. 1. 1400 w.

7399. The New York and Queens County Electric Railway. J. E. Woodbridge (Describes briefly the line, power plant and equipment with photographs and diagram of car wiring). Elec Wld–Aug. 1. 900 w.

7400. The Hardie Compressed Air System (Description with quite full data of the plant at Rome, N. Y., and compressed air car, with a few notes of speed and traction performance). Elec Wld–Aug. 1. 2000 w.

*7429. Permanent Way. W. Lawford (Urges the extreme importance of good ballast and good ballasting). Eng, Lond–July 24. 2000 w.

7459. Third Rail Conductors. Leo Daft (Illustrated account of a few experiences with third rails as conductors). Elec Eng–Aug. 5. 1200 w.

7461. The Trolley Base Suit (Decision just rendered by the Circuit Court of Appeals in New York, involving the manufacture and use of trolley bases. Opinions in full, with editorial). Elec Eng–Aug. 5. 4200 w.

7462. Accident to An English Racing Train (Comments on the curious change of attitude of the British press on account of an accident, and questions whether high speed is objectionable on any other ground than that of economy). Ry Age–July 31. 900 w.

7463. The Pooling of Freight Equipment, J. R. Cavanagh (Read before the Assn. of Ry. Officials at Toledo, O. Some practical suggestions as to how to do it). Ry Age–July 31. 1900 w.

*7464. Staybolt Seating Machine. John Randol (Describes the construction and operation of an excellent special device, with illustrations). Loc Engng–Aug. 2000 w.

*7465. Steel Cars—Norfolk & Western Railway (Description, general construction, with partial detail drawings). Loc Engng–Aug. 800 w.

*7466. Rules for Calculating and Designing Driver-Brake Gear of the Push-Down Type (Gives general formula and examples of application to special cases). Loc Engng–Aug. 500 w.

*7467. Air-Brake Practice on the Fitchburg Railroad. H. S. Kolseth (Describes a method adopted with excellent success, for increasing the efficiency of engineers in handling the air-brakes). Loc Engng–Aug. 900 w.

7468. Stations of the Union Elevated Loop, Chicago (Description with sectional drawings and elevations). Ry Rev–Aug. 1. 1200 w.

*7469. The Railways of India (A review of mileage, traffic and earnings. which last are said to be very satisfactory). Trans–July 24. 1100 w.

7487. The Grade Crossing Collision at Atlantic City (Account of the circumstances in connection with the disaster gleaned from various sources, with editorial comment and suggestions). Eng News–Aug. 6. 3300 w.

*7542. Chinese Railways and British Trade (Description of the history, present construction, operation, cost, engineering features, and projected extensions, with some notes of prevailing foreign influences). Ir & Coal Trds Rev–July 31. 1000 w.

7545. On the Measurement of the Insulation Resistance of Street Railway Cables. Edwin J. Houston and A. E. Kennelly (Describing a method which is said to eliminate the usual difficulties experienced in testing underground cables). Elec Wld–Aug. 8. 1000 w.

7546. The Syracuse Street Railway (A short illustrated description of the power plant and equipment). Elec Wld–Aug. 8. 1000 w.

*7547. The Railways of India (A review of the finances of the India roads; their earnings and expenses; and a summary of recent and current construction). Trans–July 31. 1800 w.

†7548. Administration Report on the Railways in India (A review of the government report, with explanation and critical comment). Ind Engng–July 4. Serial. 1st part. 1300 w.

7558. Suspensions Abolished on the Southern Pacific (Description and illustration by example of a new system of discipline). R R Gaz–Aug. 7. 1600 w.

7559. Track Elevation on the Milwaukee Division of the Chicago and Northwestern Railway (General description of the proposed work, with quantities of materials involved and methods of work adopted). R R Gaz–Aug. 7. Serial. 1st part. 1100 w.

7560. The Atlantic City Collision (Editorial, using the accident as a text for a discussion of safety measures at grade crossings). R R Gaz–Aug. 7. 1200 w.

*7562. The Lührig System of Gas-Motor Tramway Cars. G. Grosch (Brief description of a system said to be in successful operation in Dresden). Ind & East Eng–July 11. 600 w.

SCIENTIFIC MISCELLANY

The Sea Mills of Cephalonia.

We venture to say that many of our readers are not even aware of the existence of a singular phenomenon, described in *Technology Quarterly* for March by Mr. F. W. Crosby and Mr. W. O. Crosby jointly,—a phenomenon that has never been satisfactorily explained, unless the plausible explanation offered by the authors of this very interesting paper may now be accepted as sufficient. A natural curiosity not generally mentioned in books describing the Grecian possessions, but one which has occasionally excited the curiosity of travellers, is located at a point on the coast of the Island of Cephalonia, one of the Ionian group. Here an unintermitting current of sea water flows into the land for a distance of about fifty yards through an artificial channel, and then plunges down into clefts and fissures, and disappears. The current is quite uniform, and is not the result of tidal action, since the rise and fall of the tides at the point named is very slight. A quotation from Baedeker's "Greece" introduces the description of this singular current, as personally observed by one of the authors of the paper revieved.

"From the Maitland Monument we may proceed along the coast, past the British Consulate and the large wine-cellars of Mr. Toole, to the celebrated Sea Mills. The first of the latter is the mill of Dr. Migliaressi, established in 1859, and one-fourth mile farther on, at the north end of the peninsula, is the old mill, erected by Mr. Stevens in 1835, where we obtain a better view of the phenomenon from whence the mills derive their name. The mills are driven by a current of sea-water, which flows into the land for about fifty yards through an artificial channel, finally disappearing amid clefts and fissures in the limestone rock. Authorities are not yet unanimous as to the explanation of this unique phenomenon."

Incredulous as to the accuracy of this (Baedeker's) account, which seems out of accord with natural laws, Mr. F. W. Crosby visited Argostoli to see for himself.

"A mile north of the town, at the extremity of the promontory and the mouth of the harbor, are the Sea Mills. The entire promontory is composed of the ordinary bluish white Secondary limestone. It is nearly destitute of soil and vegetation, and the surface is very rough and ragged from unequal weathering. The land is low and flat at the north end in the vicinity of the mills, but it gradually rises as it trends southward, and between the town of Argostoli and St. George's Castle, five or six miles distant, attains a height of two hundred to three hundred feet or more. Although Mr. Stevens, in 1835, was the first person to utilize this anomalous water power, the existence of the running water had long been known to the natives without exciting any special interest in their minds. The mills have not been running for years, and are now in a state of dilapidation and decay. Each race, or flume, is continued for a few yards beyond the mill, and terminates in an irregular pit excavated to a depth of three to five feet below the sea-level. From this discharge pond, as it might be termed, the water rapidly disappears through numerous narrow openings,—seemingly enlarged joint fissures. The races have a breadth of four to six feet, and the bottoms slope inland sufficiently to insure a strong current at the mills. The wheels in both mills were of the undershot type, of rough country make, and connected by means of equally crude gearing to the millstones within the mill.

"The only difficulty experienced in operating the mills was to prevent the ingress of seaweed and other trash which would choke up the discharge vents. At the Stevens Mill gratings were used for this purpose, but occasionally the crevices in the rock had to be cleaned out, as more

or less weeds would get through the grating. Dr. Migliaressi, at the new mill, improved upon this by building a walled inclosure about forty feet square in the sea, around the mouth of the flume leading to his mill. The wall, being laid without cement below the surface of the water, gave access to the water, but kept out the obstructing seaweed. In all other respects the mills were practically alike."

The influx of water described extends along the coast for about a half mile. "The water is everywhere percolating through the cracks and fissures of the limestone and sinking into the earth." Mr. Crosby estimates that not less than four thousand cubic feet per minute thus disappears, and he very justly supposes that the hypothesis of a cavern receiving this amount of water hourly for a century or more must be of a size very far exceeding any existing cavern known. He therefore rejects this hypothesis altogether for an explanation which he thinks may fit the facts, and which is certainly much more acceptable than the cavern hypothesis.

The authors have been unable to find any reference to this subject in any strictly scientific work, except an account of it given by Mr. H. E. Strickland, an English geologist, who observed it in 1835, and described it in a treatise published shortly afterward. He believed that the water entering the fissures was subsequently evaporated by currents of air upon the surface of the land and circulating through innumerable fissures in the rock, the latter acting very much like a sponge exposed to air and sun at the top, and to inflowing water at the base. In consequence of this evaporation, the water in the caverns would always be lower than in the sea, and hence the water would flow in through the open fissures.

If evaporation is thus going on through long periods, it seems that a constant deposit of salt must occur in the fissures, and this would probably terminate the action by stopping up the passage, were it not that frequent earthquakes occur in this region, causing new fissures. Mr. Strickland held the opinion that large deposits of salt were thus forming in the caverns, and he quotes Professor Ansted as having estimated the rate of deposit from the evaporated sea water as annually not less than 1,800 cubic yards. It is, however, a singular fact, in connection with this hypothesis, that there are no springs on the island that contain any notable amount of salt. Clearly, such a deposit as this could not have been progressing during a century without very largely obstructing the inflow of water by filling up fissures, or without charging springs with saline matter. The difficulties in accepting evaporation as a sufficient explanation are therefore so great that it will probably be rejected by most scientists.

For the theory of evaporation the authors of the paper under review substitute a mechanical theory which seems more plausible, yet which is also not exempt from difficulties. If a bent tube be filled with water and set so that its open ends are both at the same level, and if one of the branches above the lower part of the tube be heated, water will temporarily flow out of the upper end of the heated branch; and, if the open end of the cooler branch be so arranged that water can constantly flow into it, circulation will be set up toward and through the hotter branch, which will constantly dischareg as much water as flows into the cooler end. Such a circulation would take place with the end of the heated branch somewhat higher than that of the cooler branch, the difference in height depending upon the temperature maintained in the warmer branch as compared with that of the cooler branch, and the consequent difference thus created in the specific gravities of the two water columns. A U-shaped tube, with its open ends inserted through and soldered to the bottom of an open basin containing water, would, upon warming one of the branches, well illustrate this action, for which, also, an analogy may be found in hot-water heating apparatus for warming buildings, and in some constructions of water-tube boilers. Such an arrangement may be conceived as typifying the state of things at Argostoli. Water flowing down one branch of a fissure may, by becoming warmed in another branch, be caused

again to ascend, and thus a continuous flow would be established. The internal heat of the earth is supposed to maintain this action. The fact that seismic phenomena are of frequent occurrence in the Ionian islands lends plausibility to this assumption.

Tornadoes and their Causes.

TAKING as a text the great damage done in St. Louis by the tornado of May 27, *Engineering* (July 3) states editorially the conditions which preceded the storm, regarding these conditions as conforming to the laws of such storms "so far as they are understood." The saving clause quoted is of some importance, for, the more the subject is studied, the more the mind of the student will be forced to admit mysteries connected with tornadoes that scientists have not yet been able to penetrate. To speak of law in phenomena, each of which has exceptional characteristics when referred to the so-called law, seems hardly logical; yet there are some features in the genesis of these storms which seem to be uniform. The weather bureau reports show that "cold winds were blowing from the north and northwest, and that warm southerly winds met the cold currents in the near vicinity of St. Louis."

We know experimentally some of the results of mixing warm, humid air with colder air. Condensation of moisture always occurs. Depending upon the difference of temperature in the bodies of air which thus meet and upon the rapidity with which they commingle, the condensed moisture takes the form of clouds, rain, snow, or hail. But tornadoes do not always result from the meeting of such currents. Usually, however, there are high winds. Evidently the production of a "twister," such as is a too familiar phenomenon in the west, involves something more than the meeting of two air currents having widely different temperatures.

Professor William Blasius, about the middle of the century, made a study of tornadoes. The conclusions he arrived at seem to have been accepted without question by *Engineering* in the article under review. He believed that the primary condition for the genesis of a tornado "is the encounter between polar and equatorial currents, which, just prior to the outbreak, balance each other along their line of meeting, compressing the air beneath and causing the extreme sultriness that precedes the outbreak. It may, and does sometimes, happen that the effects of the collision are averted by a sudden change in the direction of the air currents; but if, as is usually the case, some local disturbance occurs, the heavier and colder air from the north will sink, causing a depression above into which the warmer air from the south then rushes violently, and, with a change in its direction, produces an eddy, the commencement of the tornado. The appearance of a circular whirling cloud, produced by rapid condensation, is the first indication of the approaching crisis. As the transposition of the colder and warmer volumes of air continues, the cloud grows darker and larger, at the same time descending in funnel shape towards the ground. The outside of this rapidly-revolving cone rises in temperature on account of the latent heat set free by condensation, while within the temperature is lower because of the rarefaction produced by centrifugal force. Blasius says, in reference to this stage of the storm:

"When the tornado-cloud has approached the ground, the surrounding air on the surface will rush into the space of rarefied air of the vortex with a velocity proportionate to the difference of pressure outside and inside the mass. This current will be made visible by a mass of detached objects, such as sand, dust, or water, which it whirls up off the ground. Thus a second cone, looking like a cloud, with its base on the earth, will be attached to the inverted cone of the tornado-cloud, which has its base in the cumulo-stratus of the south-east storm.

The path of the tornado is comparatively limited; it seldom exceeds twenty miles in length and six hundred yards in width. The form of the rapidly travelling and revolving cone of cloud varies con-

stantly. It is described by eye-witnesses as taking a zigzag forward motion, and as rising and falling,—many comparing it in form and lateral movement to an elephant's trunk. In 1851 there was a famous tornado at Cambridge, near Boston, Mass., almost as violent as the recent one at St. Louis, though destructive only to the trees and scattered houses that lay in its path The phenomena were closely watched by many observers. One witness said: "It seemed to act on a building as a mill grinds whatever is put into it. If every square foot of atmosphere in the column had been armed with a steel tooth, and the buildings and trees which went into it could have passed through it, it could not have shivered them to smaller pieces. . . . It seems as if a vacuum had travelled (if we can say so) fifteen or twenty miles from west by south to east by north, and the wind had rushed in with violence, not only behind it, but on each side towards its central line of motion, prostrating the trees in the manner above stated."

Now, it is easy to show that the primary condition, named by Blasius, is by no means the only condition; were it such, its establishment would be invariably followed by a tornado. As a matter of fact, tornadoes, in the majority of cases wherein this primary condition exists, do not follow. Such storms are occasional and exceptional. A description of what was seen at St. Louis before the storm burst is interesting in this connection.

"The conditions of temperature and humidity had been quite abnormal for several days prior to the fatal Wednesday. About noon of that day the barometer commenced falling, and the sky was covered with cumulo-stratus clouds, reversed in form; these gradually took a regular stratified position, and in the northwest assumed a vivid green hue. At 4 P. M. thunder and lightning commenced at 4.30 rain fell heavily; and at 5 the storm burst out in full fury, rushing with great rapidity at first from north-west towards south-east, and changing its direction later.

At 5.15 P. M. the wind blowing from the north-west was credited with a velocity of eighty miles an hour, and during ten minutes, from 5.20 to 5.30, the barometer fell to 29.35. This completed (about 5.15) the first period of the storm, but not the disastrous period. It was accompanied by the long cone cloud descending towards the ground, and by an extraordinary electrical display.

"Against a background of various tints of green, forks and sheets and luminous balls of fire, colored purple and red and blue, shot out, accompanied by roars of thunder. All the while to the south the sky remained bright and nearly clear. During the second period, lasting about twenty minutes, nearly all the destruction was wrought. The great velocity of the wind had abated, and rain fell in torrents; between 5 and 9 P. M. 3.04 in. were measured. But during the short crisis those who made the experience were able to realize to some degree the illimitable power of the forces of nature. The clouds descended to the housetops, wrapping the city in darkness, except for the lightning. The irresistible power of the cloud vortices swept everything from their path, uprooting trees and twisting around large trunks that proved too resistant, transporting wagons and horses, levelling buildings, and turning everything in the line of the storm to nearly universal ruin. The vast network of wires that almost obscured the light in the streets of St. Louis added to the destruction and the horror of the scene. In every direction the long lines of telegraph poles were flashing pillars of blue flame. The wires were strings of fire, and the insulators were blazing bunches of sizzling wires."

The evidence that electricity was one of the forces concerned in this storm is most conspicuous in the description we have quoted. "At 4 P. M. thunder and lightning commenced." When the long coned cloud formed, "forks and sheets and luminous balls of fire, colored purple and red and blue, shot out, accompanied by roars of thunder," constituting what may be truly called "an extraordinary electrical display." Further, "the telegraph poles were flashing pillars of blue flame," and "the wires were strings of fire." Now

allowing much for rhetoric in these descriptions, it is impossible to disregard the fact that a violent electrical discharge of energy was going on when this storm reached its climax, and that some of the effects produced can be more readily accounted for by referring them to electricity than by the supposition that the *vis viva* of air currents was their sufficient cause. When, if ever, the true inwardness of tornadoes becomes known, electricity will doubtless be recognized as at least one of the most potent forces concerned in them.

Helium and Argon.

THE obstinacy with which these two newly-discovered chemical elements refuse to combine with other substances is confirming the belief that they are what chemists style non-valent,—that is to say, in no proportion are they capable of entering into combination with other substances. If so, they will add another argument to those already brought forward against universal design in nature. If these substances react with no other substance, what use or design can they possibly subserve in the universe? *Nature* (June 11) gives an abstract of a paper by Prof. William Ramsey and Dr. J. Norman Collie, read before the Royal Society (May 21), in which these eminent scientists record the efforts they have made to obtain reactions with substances deemed the most promising, and state their entire failure. "The plan of operation was to circulate helium over the reagent at a bright red heat, and to observe whether any alteration in volume occurred—an absorption of a few c. c. could have been observed—or whether any marked change was produced in the reagent employed. As a rule, after the reagent had been allowed to cool in the gas, all helium was removed with the pump, and the reagent was again heated to redness, so as, if a compound had been formed, to decompose it and expel the helium. Every experiment gave negative results; in no case was there any reason to suspect that helium had entered into combination." Sodium, silicon, beryllium, zinc, cadmium, boron, yttrium, thallium, titanium, thorium, tin, lead, phosphorus, arsenic, antimony, bismuth, sulphur, selenium, and uranium oxid were some of the substances experimented with. Argon and carbon do not react even under prolonged heating. Chlorine and helium exposed to silent electrical discharge for several hours remained unchanged. Helium is not absorbed by cobalt powder at red heat, and platinum black, a most energetic absorbent of other gases, does not occlude it.

Among other experiments induction sparks passed through a mixture of helium and benzine vapor for many hours produced no effect upon the helium, though the benzine vapor was altered in the same way as it would have been had nothing but benzine been present. We have, therefore, now in the catalogue of chemical elements, two which appear entirely inactive, and therefore useless in the economy of nature.

Minerals Associated with Burmese Rubies.

IN *Philosophical Transactions* is presented an account of some minerals collected by Mr. C. B. Brown while carrying out, under orders of the secretary of State for India, an investigation of Burmese ruby mines.

Details are given, with maps, of the physical geography and geology of the region and the rude processes employed by the natives in mining the gems. They are for the most part washed out of alluvial material filling hollow basins and clefts in a limestone rock, but their original situation, as proved by Mr. Brown, is in the rock itself. This is a hard, crystalline limestone interbedded with gneiss, and by breaking some of it to fragments Mr. Brown obtained in ten days fourteen rubies from one and a half cubic feet. These were, of course, injured much by the jarring necessary to break up the stone, but they showed that by better methods the gems could be obtained in larger quantity.

Prof. Judd says: "The limestone which the rock in Burma most closely resembles is undoubtedly that of Orange Co., N. York, and Sussex Co., N. Jersey, which is associated with the remarkable deposits of zinc ore at Franklin Furnace. The

general conclusion to which we have been led concerning the origin of the rubies of Burma is as follows: Pyroxene gneisses abound with an unstable basic feldspar, which is easily converted by minute quantities of hydrochloric acid under pressure into a scapolite, this in turn breaking up into various hydrated aluminum silicates and calcite." *Ameriean Geologist* says, with reference to the formation of rubies, that, while the limestones are being formed from basic feldspars, the aluminum silicates, taking up water, may be attacked by sulphuric, hydrochloric, boric, or hydrofluoric acid at moderate temperature and decomposed, the aluminum oxid, in some cases anhydrous, being formed, which may assume the crystalline form. The presence of carbonic acid in the liquid state in some of the cavities indicates formation under great pressure.

Ductile Cast Iron.

WE are hearing something of a new material turned out by a company in East Chicago, and find in the *Iron Age* a statement in regard to it. It is said that castings of this metal (called ductile cast iron) as large as ten thousand pounds can be made, and the claims further put forth are very remarkable. The castings are said to be homogeneous, free from blow-holes, may be drawn under hammer, perfectly welded, and are workable, like wrought iron, by machine tools. Tests of the metal have, it is alleged, shown it to possess a tensile strength of from 63,000 pounds per square inch to 80,000 pounds.

Iron Age says that, "after being heated to a dull red and plunged into cold water, the metal can be cut easily with a file, showing that it takes no temper. Specimens of castings are shown which have had portions heated and drawn out flat under the hammer, afterward being twisted cold and pounded flat, without a sign of fracture. Gates from castings are shown which have stood remarkable torture of this character. A notable piece of work is a heavy chain, of which the links were cast open, then joined, and the open spaces welded without the use of flux. Valve stems, crank shafts, and other similar pieces are shown, which have been finished to pattern in a lathe, exhibiting a smooth surface without a suspicion of a blow-hole. Intricate castings are exhibited which have been reproduced regularly without a failure, while a very high percentage of losses has been reported when made by other methods of producing very strong castings."

It is said to be the intention of the company "to meet the demand for castings of the highest grade, competing with drop forgings, and aiming to produce shapes which are difficult to work under a hammer, but for which castings have heretofore not been found sufficiently strong and trustworthy." The castings are also said to be "well adapted for electrical apparatus, owing to their high conductivity."

THE *Engineering and Mining Journal* says that Madagascar is an exceptionally good field for mineral prospecting, so far as the natural conditions are concerned. The climate of the interior plateau is good, and in the mountains (9,000 to 10,000 feet) even cool, though on the coast it is hot. There is plenty of timber and water, but transportation is thus far in a primitive stage.

THE ENGINEERING INDEX—1896.

Current Leading Articles on Various Scientific and Industrial Subjects in the American, English and British Colonial Scientific and Engineering Journals—See Introductory.

6988.—75 cts. The Sea Mills of Cephalonia. F. W. Crosby and W. O. Crosby (Excellent description and attempted explanation of a very singular phenomenon which has been observed many years hitherto without satisfactory explanation). Tech Quar-March. 7500 w.

6990.—75 cts. Reduction of Nitrates by Bacteria and Consequent Loss of Nitrogen. Ellen H. Richards and George William Rolfe (Interesting experiments which lead to the conclusion that bacteria are active agents in the disappearance of nitrogen in nitrogen-compounds dissolved in water). Tech Quar-March. 3600 w.

6991.—75 cts. The Graduation of a 100-Inch Photometer Bar. W. Lincoln Smith (Presents a table of scale readings in inches and corre-

We supply copies of these articles. See introductory.

sponding ratios of unknown to standard which, when multiplied by the value of the standard in candle powers, gives directly the value of the unknown. Also explains the method by which the table has been obtained). Tech Quar–March. 350 w.

*7007. The Tornado at St. Louis. Ill. (Conditions for the genesis of storms of this character). Engng–July 3. 1700 w.

*7024. Individuality in the Mineral Kingdom. Henry A. Miers (An inaugural lecture delivered at the University Museum, Oxford, Eng. An interesting address). Nature–July 2. 6000 w.

7036. The Standing of Engineering Among the Professions. J. S. Kreerl (Read before the Montana Soc. of Civ. Engs. A discussion of the fitting recognition of the engineering profession). Arch & Build–July 11. 1200 w.

7037. Asbestos. George Heli Guy, in *New York Evening Post* (What it is; where found; the process of manufacture; its uses). Arch & Build–July 11. 1800 w.

†7062. The Contractor's Fair Profit. John H. Burnham (Consideration of what is a fair profit, with discussion). Ill Soc of Engs & Surv–11 An Rept. 4200 w.

7070. Röntgen Ray Tubes. Elihu Thomson (Criticising some statements made in articles appearing in this paper, and illustrating various forms of tubes). Am Elect'n–July. 800 w.

7075. The State of the India Rubber Supply. Hawthorne Hill (Showing that there is little fear that the price of rubber will be increased materially in the future). Elec Eng–July 15. 1800 w.

7078. Emission of New Radiations by Metallic Uranium. Henri Becquerel, in *Comptes Rendus* (Study of these salts with results of scientific interest). Elec–July 15. 900 w.

7079. On Hyperphosphorescence. Silvanus P. Thompson, in *Philosophical Magazine* and *Journal of Science* (Explains why the writer gives this name to the new phenomenon observed by M. Becquerel and by himself). Elec–July 15. 600 w.

7119. Decimal Numeration in the United States. E. E. Slosson (The use of it is regarded as on the increase, and the author appears to anticipate its general adoption). Science–July 17. 1800 w.

7120. The Use of the Hair Hygrometer. C. C. Trowbridge (Results of tests of Saussure's hygrometer in comparison with results of the wet and dry bulb determinations of humidity in air, show a nearer agreement than would be generally supposed). Science–July 17. 1100 w.

*7151. The Manufacture of White Lead. G. H. Robertson (The methods at present employed and the substitutes proposed). Elect'n–July 10. 2000 w.

*7152. Electrostatic Deflection of Cathode Rays. G. Jaumann (Showing that the electrostatic deflection of cathode rays is as characteristic of them as their magnetic deflection). Elect'n–July 10. 3500 w.

†7169. The Teak Trade of Siam (Report to the Colonial Office of Acting Vice-Consul Black of Bang Kok (Interesting description of the teak timber industry in its details from cutting to marketing). Ind & East Eng–June 27. 3200 w.

7178. Cotton. Henry G. Hester (Its relation to leading American seaports, past and present; the future of New Orleans as a cotton center; an original and interesting review of the cotton trades of the south as compared with the ante-bellum period). Mfrs Rec–July 17. 4000 w.

7179. How Cotton Is Bought, Sold, and Handled (General information by a member of a cotton firm). Mfrs' Rec–July 17. 1100 w.

7189. New Tesla Coil for X-Ray Work (Describes a coil known as the modified Tesla coil, placed on the market by the L. E. Knott Apparatus Co). Elec Rev–July 22. 700 w.

7217. The Effect of Inventions on the People's Life (Changes in the condition of the people resulting from inventions chiefly pertaining to the daily life, food, raiment, methods of working, books, newspapers, etc). Sci Am–July 25. 3500 w.

7221. Physics (Review of progress in physical sciences for the last half century). Sci Am–July 25. 1500 w.

7222. The Textile Industries of the United States Since 1846 (Review of American progress in the textile arts, with statistics). Sci Am–July 25. 2000 w.

7224. Chemistry (Rapid review of fifty years of progress). Sci Am–July 25. 1500 w.

7225. The Phonograph (An illustrated historical sketch). Sci Am–July 25. 1400 w.

7233. The Progress of Invention During the Past Fifty Years. Prize essay by "Beta" (Edward W. Byrn) (A diagram showing ratio of increase of U. S. patents for each five years, and another, showing yearly increase or decrease, and the relation of increase or decrease with critical periods in the history of the country, are interesting features of this able essay). Sci Am–July 25. 2200 w.

7234. Distinguished Inventors (Biographical sketches with portraits). Sci Am–July 25. 2800 w.

7236. Development of the Astronomical Telescope in Fifty Years (Historical, principally dealing with what American genius has accomplished toward perfecting these instruments.) Sci Am–July 25. 2400 w.

*7247. The Surviving Hypothesis Concerning the X-Rays. Dr. Oliver Lodge (The present aspect in the light of recent experimental progress. Exposition of the meaning of a prediction of Helmholtz, dating back to the early part of 1893). Elect'n–July 17. 2800 w.

*7248. Some Experiments with Röntgen Rays. John Burke (An account of some experiments the writer has been carrying out at Owens College). Elect'n–July 17. 1800 w.

†7262. Colombia: Region of the Magdalena; Trade of Barranquilla (The river system

of the country and facilities for the establishment of ports, with reference to present and future commercial requirements are discussed). Cons Repts–July. 4200 w.

†7268. The Sugar Industry of Formosa (Described from personal observation, by James W. Davidson. Copied from *Japan Daily Mail*). Cons Repts–July. 4300 w.

†7269. Cider Making in France (Description in detail from the selection of the apples, to the final bottling of the rectified cider). Cons Repts –July. 3800 w.

7270. The Temperature of Certain Flames. W. Noll Hartley (Description of attempts to ascertain temperature of flames). Am Gas Lgt Jour–July 27. 1600 w.

7271. The Relative Humidity of Southern New England and Other Localities. Report of Alfred J. Henry, Chief of Div. of Weather Bureau, U. S. Dept. of Agriculture (Results in tabulated form of extensive observations in various localities, with explanatory remarks upon the methods and their accuracy, and comparisons of humidity of different regions. Also diagrams showing curves of relative humidity, and statement of the relation of atmospheric humidity to kinds and quantities of useful crops). Bos Jour of Com–July 25. 5300 w.

*7293. Technical Education in Japan (Survey of progress with references to and brief memoranda of facilities afforded by technical schools already established). Engng–July 17. 2200 w.

7308. An Improved Focus Tube. Joseph F. Smith (Illustrated description of a tube that has given excellent results, with sciagraph of hand, showing shot). W Elec–July 25. 500 w.

†7329. Laboratory Note in the Heat Conductivity, Expansion and Fusibility of Fire-Brick. J. D. Pennock (The samples examined were Grecian magnesite, American magnesite, silica brick and coke oven tiling made in Belgium and used in retort coke ovens). Trans Am Inst of Min Engs–July. 700 w.

7367. A Possible Solution of the Problem of Weights and Measures. Sidney A. Reeve (An argument in favor of the duodecimal system and against the decimal system of weights and measures). Eng News–July 30. 800 w.

7373. Color Testing. Charles H. Williams (Read before the Boston Soc. for Medical Improvement. Experience with different methods examining a large number of men on the Burlington system of railroads. Description of a modification of Thomson's stick, employed for testing color vision, with other interesting and instructive particulars). R R Gaz–July 31. 3800 w.

†7395. Science at the University of Pennsylvania. Lewis R. Harley (Historical and general description of this institution, with illustrations, exterior and interior views, and more detailed description of departments in which chief contributions to science have been made). Pop Sci M–Aug. 7000 w.

†7396. Early Years of the American Association. William Henry Hale (This brief early history of the association is illustrated by portraits of eminent men who have presided over its councils). Pop Sci M–Aug. 1800 w.

†7397. The Scallop. Fred Mather (Illustrated description of this mollusk, its habitat, and the scallop fishery, methods of taking, and the preparing for market). Pop Sci M–Aug. 2700 w.

†7403. Forest Fires in New Jersey. John Gifford (Causes, the removal of which is imperative, and the effects of these fires upon timber, soil, seeds and game. Methods of fighting these fires when once started). Jour Fr Inst–Aug. 3000 w.

*7433. The Geological Formations Traversed by the Principal Rivers of England. Joseph A. Dickinson (From a paper read before the Manchester Geological Soc. on River Valleys. The rivers are geographically classified in six divisions, and examined). Col Guard–July 24. 3800 w.

*7438. Traction Engines and Roads (The topics of weight of traction engines as related to the sustaining power of road surfaces, legal restrictions and licenses, are considered from the English standpoint). Arch, Lond–July 24. 2000 w.

7442. The Diseases of Occupations. John S. Billings (Lecture before the Pratt Inst. The special diseases and accidents whose prevalency is increased by the various industries of civilization, or which are peculiar to particular industrial occupations are stated, with interesting facts connected therewith). Prog of Wld–Aug. 3500 w.

7452. The Burma Teak Forests. Dietrich Brandis, with editorial (The history of the management of these forests, given with some detail). Gar & For–Aug. 5. Serial. 1st part. 2600 w.

*7526. The Röntgen Rays. J. J. Thomson (The Rede lecture, given at the University of Cambridge, Eng. Brief reference to the discovery, with discussion of the rays and the effects they produce, etc). Nature–July 30. 6000 w.

7534. The Action of Illuminating Gas on Rubber Tubing. H. Grosheintz, in the Bulletin of the Industrial Society of Mulhouse (An account of experiments carried out by the author). Am Gas Lght Jour–Aug. 10. 900 w.

†7535. History of the Rubber Industry in New Brunswick, New Jersey. T. Robinson Warren (Historical account of this industry and the benefit it has proved to the town). Ind Rub Wld–Aug, 10. 2500 w.

†7536. The Management of India-Rubber Plasters. H. W. Medberry, in *The Western Druggist* (From an address delivered before the students of the Chicago College of Pharmacy. Gives brief history of plasters and describes the rubber plasters and their manufacture). Ind Rub Wld–Ang. 10. 1500 w.

†7537. Rubber Notes of Interest from Canada (Interesting information connected with trade in india-rubber). Ind Rub Wld–Aug. 10. 2000 w.

†7538. The India-Rubber Industry in Europe (Interesting notes from various sources). Ind Rub Wld–Aug. 10. 1600 w.

COMMENT & CRITICISM

The Price of Gold.

IN the May number of this magazine there appeared an article on "The Present Value and Purchasing Power of Gold." This contained some statements which deserve a word of criticism. In these latter days of loose thinking and still more loose talking, we cannot be too exact in our statements. The first sentence of the paper is, indeed, a fact. "The value of gold is fixed in the long run by the cost of production." No one can successfully dispute this axiom. As the author goes on to say, price will not remain permanently below the cost of production, because men will refuse to produce that article for such a price. On the other hand, if large profits are being made, others will go into the business of producing, and these may be willing to sell at a lower price.

But the errors appear later in the article, when the statement is made that certain conditions have maintained gold abnormally above its value as determined by its cost of production; and further along the inviting prospect is presented that, because of these enormous profits, gold mining should be one of the most alluring industries of the times. While there is no doubt that gold mining is one of the most alluring industries of the times, the inferences to be deduced from these considerations is denied,—namely, that large fortunes await those who enter the field of gold mining.

In the first place, all admit that gold has value. Value has been well defined as "the power which an article confers upon its possessor, irrespective of legal authority or personal sentiments, of commanding, in exchange for itself, the labor or the products of the labor of others." This value is dependent on two conditions,—the want men have for the article and its difficulty of attainment; in other words, supply and demand. In order that anything shall be valuable, it must possess utility. One does not labor for that which he does not want. Is it true, however, that utility alone governs value? Not at all. Some of the most useful things in the world ordinarily possess but little value. Light, water, the air we breathe, are all highly useful,—in fact, absolutely essential to our life and health,—yet they are free for all, without money and without price.

The other condition of value, then, is difficulty of attainment. These two conditions of value gold possesses in an eminent degree. All men want it both for its use in the arts and for its purchasing power as money. It is also more or less difficult to procure gold in its native condition or from its refractory ores. Therefore a small quantity represents a considerable value. These conditions being as they are, we see that gold obeys the same laws that govern all other products,—namely, those of demand and supply. There may be a large demand for an article, but it does not necessarily follow that it will command a high price, as the supply may be correspondingly large. But with gold the supply and demand seem fairly to keep pace with each other. Its difficulty of attainment is practically constant, and, while there are new supplies being discovered, yet the demand for the product is continually increasing.

We now come to the main fact which was overlooked in the above quoted article,—namely, production at the greatest disadvantage. Although all gold producers may sell their product at practically the same price, it does not follow that they all make the same amount of profit. In fact, it is easily seen that the chances are that no two producers are making the same proportionate amount of profit.

This is what is meant by production at

the greatest disadvantage. As long as there is a demand for gold, men will go into the business of producing it. But some will have refractory ores to work. Others will have high wages to pay. Others may have high transportation charges against them. Thus they are not all on an equal footing. Some will be turning out gold much more cheaply than others. But do those sell their gold at a lower price than these? Not at all. Those who are producing most cheaply can be thankful for their good fortune and pocket the increased profits. But what does govern value? "The normal value of any kind of goods is determined by the cost of production of that last considerable portion of the necessary supply which is produced at the greatest disadvantage." Here, then, we have the key to the situation. Some men are in the business of producing gold who are just able to sell their product for what it cost to get it out, showing no profit. Their quota of gold is the last considerable portion of the necessary supply, but it is produced at the greatest disadvantage, and therefore fixes the price. All those who are above this plane make more or less of a profit, while those who are below it drop out, as they can not afford to produce long at a loss.

Thus it is seen why the present price of gold may not be considered abnormal. There are just as many grades of employer in the business of gold mining as any other; and business ability, cost of labor, and difficulty of attainment of product count for just as much as in any other occupation. While, therefore, it is undoubtedly true that some gold miners will make large profits, others will be found who are just able to make both ends meet, and who find that at the end of the year they are no better off than they were at the beginning. These men are necessary to the business, as without them the supply would not equal the demand and the price would go up. Others, however, would then go into the business, who would bring about the conditions as indicated herein, so that these considerations must be held to govern, and there will always be some who are producing at the greatest disadvantage. The point is, then, that some men will find gold mining, just as any other occupation, a losing business, and others will be engaged in it who are able to show a profit.

WM. ELMER, JR.

Trenton, N. J., August, 1896.

Quackery in Education.

THE article in your May number, on "Quackery in Engineering Education," by Mr. Edgar Kidwell, is not only timely, but extremely refreshing.

You were fortunate in obtaining for your contributor one who can use a pen and has sound ideas upon practical education; as he is not an engineer in private practice, it cannot be said that he writes in this vein because his own practice is being cut into by the professional professor.

Our schools, colleges, and universities are overrun with professors, men whose business it should be to teach certain branches of learning; whose best energies, mental and physical, should be directed toward keeping abreast of the times in the study and solution of the problem of practical education and to applying the same by precept and example. Men who deliver semi-occasional lectures, chiefly culled from the ancient masters, should not have the title of professor; let them be called what they more or less properly are, "lecturers." Even if we grant that the once time-honored title of professor has fallen into unworthy hands, it is nevertheless true that there are many instructors in our primary schools far more deserving of it, because they are truly successful teachers, than many of the self- or catalogue-styled professors.

Mr. Kidwell's remarks relative to the fitness of trustees of technical schools are but too true. How often we see the effect of the preponderating influence of the business man or moralist! And what is or should be a successful technical school? That one whose professors write the most articles in the *North American Review*, or publish the text-books with the greatest number of pages; that one which does the most advertising, or whose foot-ball team wins the championship, or whose register

contains the longest list of names? Or is it possibly that small, unheard-of school whose instructors have far more stubborn material to handle than the larger and more advertised schools (which from very force of numbers must fall upon specially gifted men whose later doings will add to the renown of their Alma Mater), and which yet makes of this obstinate material well-grounded, practical, thinking men,—men who will use all their senses, if necessary, to arrive at a result? Let technical schools advertise, if they must; very few are beyond the necessity; but let it not be by prostituting professorship.

There are few, if any, who will gainsay the fact that there is something decidedly wrong in the practice of college professors who devote the major part of their energies and time to private pursuits and interests. And plainly the blame for such practice rests both with the trustees and the professor. The professor maintains his association with the college, and, for a fixed consideration, does but little more than loan the use of his name and reputation to the institution. As a practical educator, he may amount to naught. With the trustees it is the question whether the institution requires advertising more than a reputation for sound training. With the professor it should be largely a question of professional ethics. Can the professor reconcile his conscience with the fact that he is deceiving both students and their parents into accepting the catalogue-conceived notion that he is actually head of his department? True, a private practice of $20,000 or $30,000 a year will act as a wonderful panacea for mangled consciences, But is not the professional quack, in usurping the place of a better fitted or more conscientious man, doing the students under him the greatest wrong and injustice, in not giving them the direct benefit of his best thought and energy? And it is not always the case that the professor has brought his reputation to the college; it has often been made while there, at the expense of the institution and its students.

The writer is not one who would make a slave of the professor. Let his institution give him all the time and money it can spare for independent study and research; but the practical results of such study and research are by right and title the direct heritage of the students.

Then, if he wish (as we hope), let him give his ideas and results to the world and reap what personal profit arises there from. It is simply that the primal end in view should be the direct benefit of the student, and not that of self.

One cannot but think that Mr. Kidwell is slightly illogical in his remarks about the "$15,000 experimental steam engine." The E. S. Allis Co. would hardly look for ideas to the crude and hastily-formed notions of college students, whose experience is confined to testing or taking down and setting up some engine. Experience, familiarity with the strength or weakness of design and operation in countless other machines, is the true ground-work for such results. And *is* experiment or practice with a $700 engine as instructive as with a $15,000 engine? With equal reason one could be satisfied with teaching the student of civil engineering the uses of the surveyor's compass, letting him get from text-books, lectures, or later life his ideas of the modern engineer's or mining transit, with its solar attachments, micrometers, stadia wires, etc.

There are many of your readers who will be glad to hear the changes rung on the subject Mr. Kidwell has introduced.

M. P. PARET.

Lake Charles, La., August, 1896.

A Correction.

IN Prof. A. Humboldt-Sexton's article on "The Important Feature of Producer-Gas," in the August number of THE ENGINEERING MAGAZINE, on page 914, "the yield of (Mond) gas from a common slack containing eleven per cent. of ash" should be stated to be one hundred and sixty thousand cubic feet per ton, instead of "one hundred thousand," as it there appears.

The error arose from a mistake in reading manuscript figures, and unfortunately the author's corrected proof was not received until after the publication of the magazine.

IMPROVED MACHINERY

NEW PROCESSES. NEW APPLIANCES.

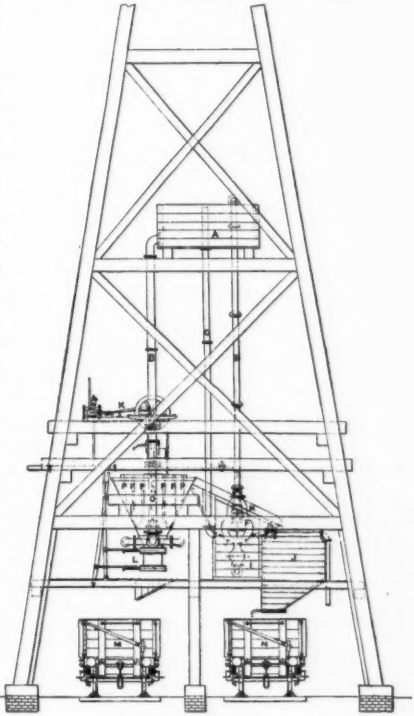
The matter published in this department is not paid for, nor can it be classed as advertising But as the information is necessarily obtained from those who offer the appliances for sale, it is proper to say that the manufacturers, rather than ourselves, are responsible for the statements made.

Tennessee Coal, Iron & R. R. Company's Coal-Washing Plant.

THE Jeffrey Manufacturing Company, of Columbus, Ohio, have taken up the manufacture of the Robinson Patented Coal-Washing Machinery, of which many installments are in daily use in this and foreign countries, and are generally conceded to be most efficient and simple. Simplicity, compactness, low cost of installation, low cost of operation, economy in the use of water, and washing of coal that is not closely sized, are special merits of this washer.

Coal-washing machinery has in the past four or five years been extensively employed in the southern States, especially in the coking plants of Alabama. The illustration, herewith, was reduced from a photo of the Robinson coal-washing plant, erected by the Tennessee Coal, Iron & R. R. Company, at their slope, No. 2, near Birmingham, Alabama. This is one of four of these plants there in daily use, the style of plant being common where the washer is used. In this plant, the run of mine coal is brought from the slope, at the far end, into the tipple house, in pit cars. The coal is dumped in the usual manner, over screens, the lump and nut coal passing into the cars; the small or slack coal, which at this plant amounts to some four hundred tons per day, is discharged into a hopper, from which it is taken by conveying machinery into the washer. The cut will be of interest, as it shows the relative position of the washer, pump, reservoir, and other parts which go to make up a complete plant.

The Robinson Washer, as now made by The Jeffrey Mfg. Co., consists principally of a well-built cone, constructed of heavy plate steel, having at its lower end a specially arranged water jacket. Inside this cone is located a rotating shaft, arranged with arms and blades, actuated by power from the head. This agitator is of wrought iron or steel, firmly secured, revolving at the rate of about eight revolutions per minute. The blades projecting down into the cone keep the material in a constant state of agitation. At the lower end of the cone are valves operated by levers. The water tank is over head and the water is fed down through pipes, out of which the water passes into the washer through various openings, so as to supply it equally on all sides. The force of the water is regulated by means of valves, so that the pressure is made to correspond



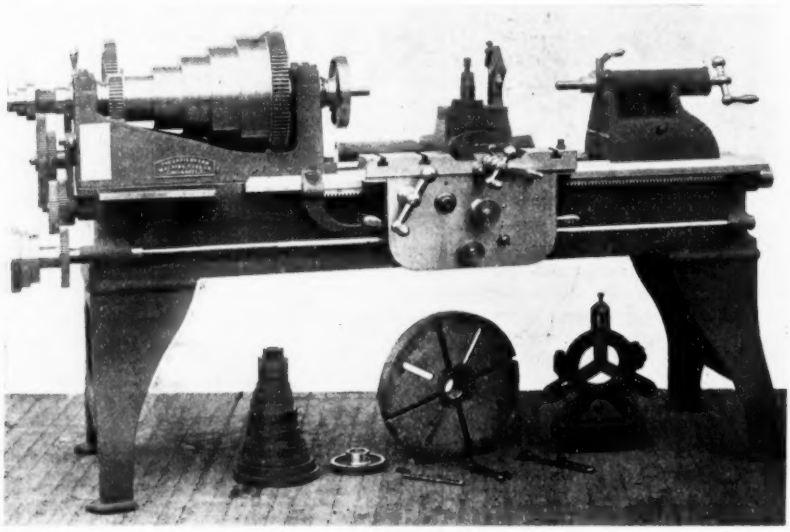
FRONT ELEVATION.

with the coal that is being washed. The overflow water is collected in a suitable tank, and, by means of a pulsometer pump, is again forced up into the reservoir for further use.

The coal is discharged into the washer, and,

passing down, meets the upward flow of the water, the clean or good coal being forced upward with the current and out at the over-flow. The heavier material or impurities, such as sulphur, slate, or bone coal, are not carried up with the water, but settle into the lower chambers. The good coal passes out with the over-flow over inclined perforated chutes into the cars, and the accumulated refuse material collected in the lower chamber is removed. The over-flow enters into a supplementary collecting chamber, known as the "Ramsey sludge," which saves a large per cent. of the very fine coal that would otherwise be lost.

In order to demonstrate the efficiency of the machinery, the manufacturers have erected a 400-ton washer in their works at Columbus (Ohio), where coal may be sent for testing purposes. A complete illustrated catalogue fully describing this machinery can be had by addressing the company at Columbus, Ohio, or branches in New York, Chicago, or Denver.



STANDARD 18-INCH LATHE.

Improved 18' Standard Engine Lathe.

THE accompanying cut shows the new 18" standard engine lathe, made by Davis & Egan Mach. Tool Co., Cincinnati, Ohio, which takes the place of the old style lathe made by the same firm. The lathe illustrated is a much heavier tool, and has many new improvements. It swings 18½" over the bed, 12⅜" over the carriage; with a 6 ft. bed, turns 3 ft. between centers and cuts threads from 2 to 35 per inch. The Driving Cone is unusually large, has five steps for 2¾" belt, and, with back gears engaged, gives ten changes of speed. The spindle is of crucible steel, accurately ground, and journaled in boxes of phosphor bronze, which are provided with means for taking up the wear and special oiling facilities. The carriage is heavy, with a long bearing on the ways, and is securely gibbed both front and back. The apron is fast to the carriage. All feeds of the carriage can be thrown in and out or reversed from the front of the apron,—a convenient and time-saving feature, as the feeds can be operated instantly. The friction feed and lead screw cannot be engaged at the same time. The cross feed is graduated into thousandths for turning diameters without callipering. By means of an automatic stop to the carriage any number of pieces may be turned or bored up to a certain point without the necessity of laying off or marking each piece. The feed rod is driven direct from the spindle, either with gearing or belt, giving a range of feeds from 7 to 142 per inch.

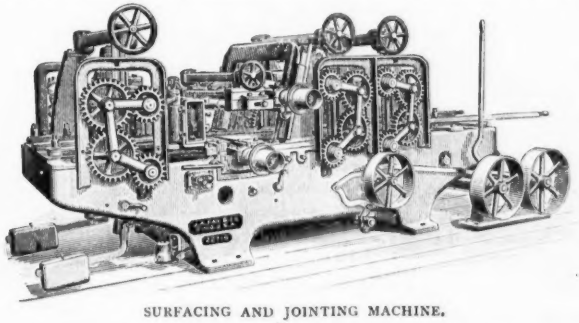
This lathe is regularly furnished with plain block rest, but a compound rest as well as a tape attachment is furnished at an additional cost. This lathe is capable of turning or boring a taper of six inches to the foot, and is fitted

with a graduated index. The tail stock is provided with set over for tapers, and the spindle is graduated so that holes of various depths may be drilled without measuring.

All gears throughout are cut from the solid; all screws and nuts are case-hardened, and all planed surfaces scraped to an accurate bearing. Each lathe is furnished with power cross feed, large and small face plates, steady rest, follow rest, change gears, and wrenches. The lathe is driven by a double friction counter-shaft, with pulleys 12″ in diameter for 3½″ belt, and should run 120 revolutions per minute.

Double Cylinder Dimension Surfacing and Jointing Machine.

THE large lumber-mills are demanding a specially heavy machine with roll feed, adapted to planing dimension timbers on four sides at one operation, as well as every variety of surface planing. The No. 12 six-roll dimension surfacing and jointing machine shown in the cut is claimed to meet the requirements exactly. It is



SURFACING AND JOINTING MACHINE.

the heaviest and most substantial timber-planer yet introduced by J. A. Fay & Egan Co., Cincinnati, Ohio. The frame is massive, with plate sides, well braced to prevent vibration when working to full capacity. The machine weighs 24,500 pounds. It will surface on two or four sides up to 30″ wide and 14″ or 16″ thick as may be ordered, and will plane two sides and one edge of two pieces of material up to 13″ wide, 14″ or 16″ thick. By using sectional feeding-rolls and bars a number of narrow pieces of varying thicknesses may be surfaced both sides at one time.

The cylinders and their journals are made from best quality, forged, crucible steel, and are slotted on all four faces. Their journals are 3″ in diameter, ground perfectly true, and run in heavy 12″ self-oiling bearings. The upper cylinder bearings are yoked together and held perfectly true with the stands by gibs on each side, in addition to a groove planed perfectly true to keep them always in line. A device for locking the cylinder is arranged and operated from the feeding end of the machine. The lower cylinder, mounted in a connected frame that can be drawn out on the operating side to permit ready access to the knives, is held rigidly in position by an improved locking device, has an independent vertical adjustment, and is placed before the side heads, as close to the upper cylinder as possible, bringing the cuts of both cylinders very close together, thus insuring uniformity in thicknessing.

The pressure-bar before the cut is sectional, adjustable to and from the cut, and arranged to lift easily for any variation in thickness up to 3″. The bar after the cut of the upper cylinder also serves as the pressure-bar over the lower cylinder. It is adjustable to and from the cut of the upper cylinder, and has an independent vertical adjustment. Two pressure-rolls, one before and one after this bar, are used in planing heavy timbers, the bar itself being raised out of the way to relieve the material from friction. These rolls are arranged to vary the pressure. The bar needs no changing when varying the thickness of the cut, for, after once being set, it always holds the same relation to the cut.

The side spindles are of fine steel $\frac{3}{16}$″ in diameter where the heads are applied. They run in three self-lubricating bearings, one being at the top above the heads, thus insuring steady running. The top bearing can be quickly removed for the purpose of changing heads. The side heads are made of steel, slotted on four faces, and are furnished 14″ or 16″ long, as desired. The side hangers are supported on heavy girts, and are held by a positive lock controlled either from the feeding end of the machine or from the operating side. They are also adjustable across the machine from the feeding end or from the side. Each head is provided with an adjustable weighted clip, permitting the chip-breaking lips to be brought close to the cut. By simply loosening two bolts the entire clip can be removed, giving free access to the knives. Press-

ure feet hold the material true to the hanger-plates, which are adjustable to suit the cut of the lower cylinder. The side guides at the feeding-out end are arranged to move with the hangers.

There are six feed-rolls 10" diameter, the upper feeding in rolls being made sectional to allow different thicknesses of narrow material to be fed through the machine at the same time. The large bearings supporting these rolls are carried in swivel boxes, and have expansion gearing at each end, yoked both inside and out. The heavy equalizer weights drop on cushions which overcome the tendency to shear the fulcrum bolts. A lever on the operating lifts the rolls instantly clear of the lumber. The lower rolls have the usual vertical adjustment. At the feeding end is an attachment for raising the upper rolls and cylinder by power. This arrangement is operated by a lever, and the positions of the rolls are accurately gaged.

All the upper rolls and the upper cylinder can be raised together, or the upper cylinder and feed-out roll can be instantly disconnected and adjusted by hand. Power is applied to the rolls by a variable friction feed, regulated from 5" to 110" per minute. This feed, separate from the framing of the machine, may be placed either overhead or below the floor, and is operated by two levers, one for starting and one for different rates of feed. By the lever that actuates the friction-plate the feed may be instantly reversed and the material fed back out of the machine.

Various attachments and appliances supplied with this machine are named in descriptive matter which the makers will supply on application.

The 35-Mile Electrical Power Transmission at Fresno, Cal.

FRESNO, the principal town of the great San Joaquin valley, in California, situated on the San Joaquin river, was founded in 1872, with the advent of the Southern Pacific railroad. At first its growth was slow, but since 1885 its population has risen to 15,000 persons. The center of a fertile and well-irrigated agricultural region, with vast mineral resources as yet undeveloped, it is the commercial center of the San Joaquin valley, and would have become a manufacturing city but for the extremely high price of fuel and consequent heavy cost of power. This handicap was felt severely by the city. The utilization of the difference of level of the San Joaquin River had been mooted, but not until the successful solution of the problem of long-distance power transmission had been reached did the utilization of the San Joaquin become possible. The San Joaquin Electric Company was formed to carry out the work, and the General Electric Company's project and three-phase system of transmission, by which power had already been successfully transmitted from Folsom to Sacramento,—a distance of twenty-four miles,—was adopted. The work, lacking a few details, is now complete, and Fresno is on a par with any city of the east so far as the cost of power and light is concerned.

The source of the water power is the north fork of the San Joaquin, which at the point of diversion runs through a narrow cañon with solid rock walls. The minimum low-water flow of the stream at this point is 50 cubic feet per second, which at the head used will develop over 7,000 horsepower at the water wheels.

A flume has been built and a canal excavated and carried seven miles along the slopes of a hill, over a right of way cleared of all obstructions for a width of 150 feet. The entire system of headworks and canal is below frost line.

As the electrical papers have done full justice to the description of the details of this plant, we will not here attempt such a description. The installment is remarkable for being an example of the longest distance transmission of power yet attempted for commercial purposes, and for being a commercial success from the start, the demand for power having taxed the resources of the company, before the plant had been running a single month.

An Economical Power Plant.

THE M. C. BULLOCK MANUFACTURING COMPANY, 1170 West Lake street, Chicago, have recently installed in the power plant of the Pabst Heat, Light & Power Co. of Milwaukee, two engines for direct-coupled alternating current two-phase work. The engines are of the Willans Central Valve type compound, automatic, non-condensing, 150 lbs. pressure, and are guaranteed to give an economy of less than 21 lbs. per I. H. P. per hour.

The two units are of 200 I. H. P. and 400 I. H. P. capacity and form with the Westinghouse alternators, a most compact and efficient plant. The plant was installed by the Pabst Company on the basis of economy of operation viewed from all the standpoints of central-station work, including economy of space, attendance, and continuous running for long periods of time with a minimum of attention. The results fully justify the time and labor devoted to this problem by the general manager, Mr. Parker, and his consulting engineers.

MUNICIPAL ENGINEERING

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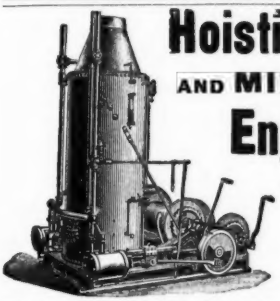

Hoisting AND MINING Engines

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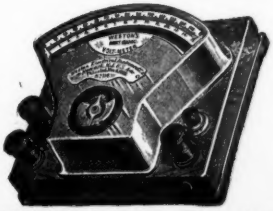

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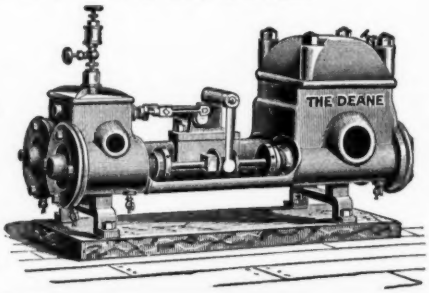

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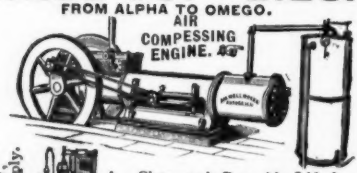

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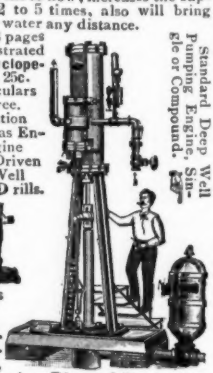

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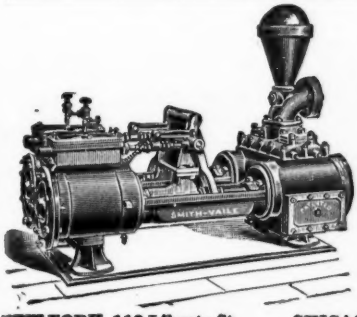

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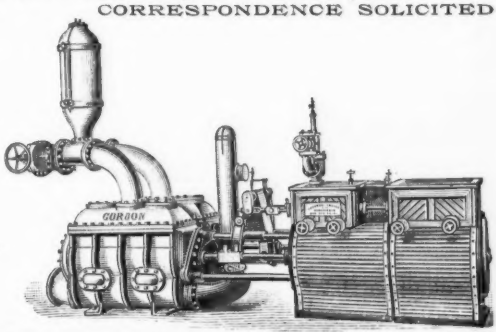

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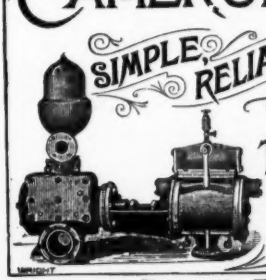

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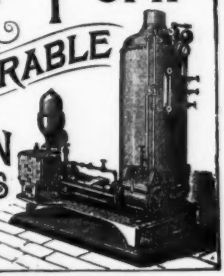

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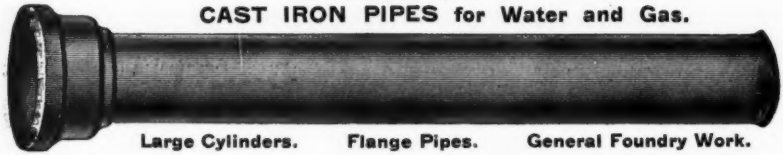

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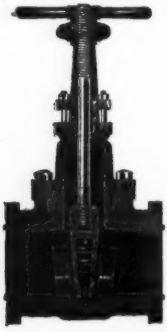

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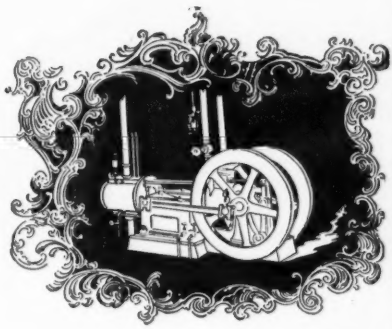

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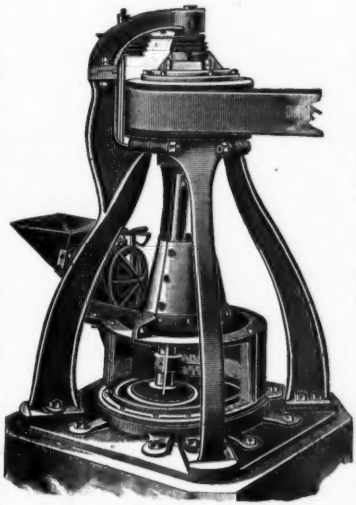

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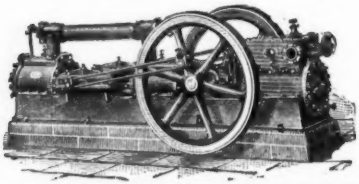

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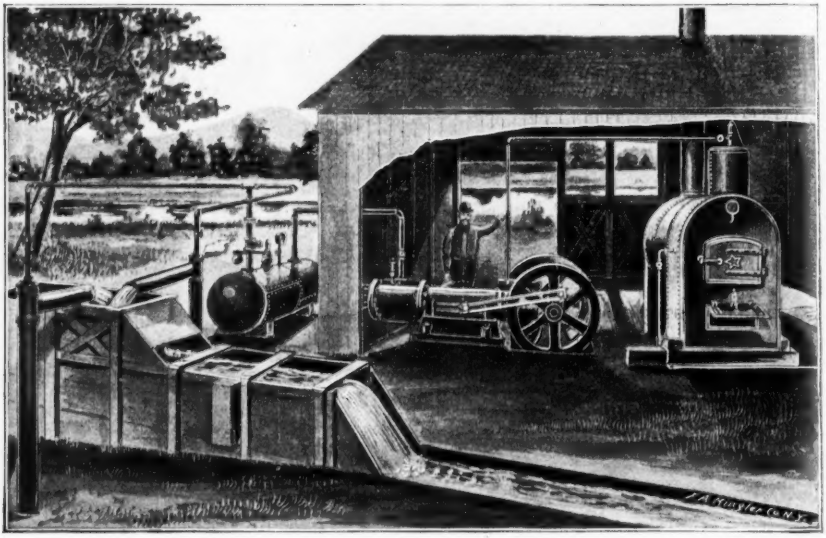

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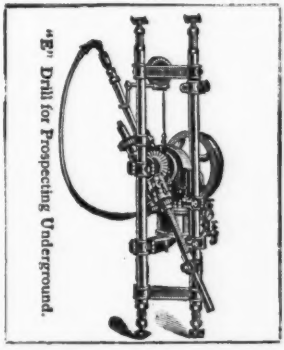

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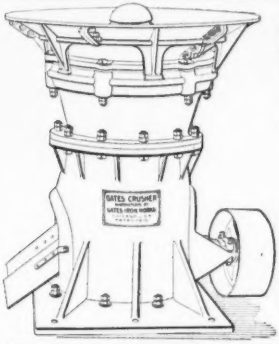

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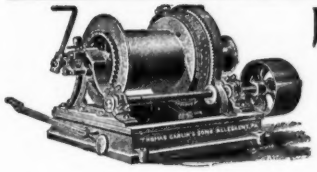

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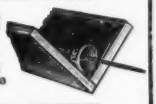

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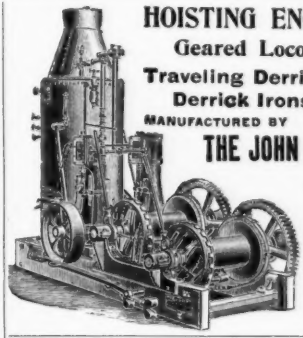

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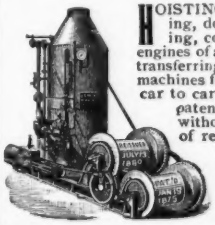

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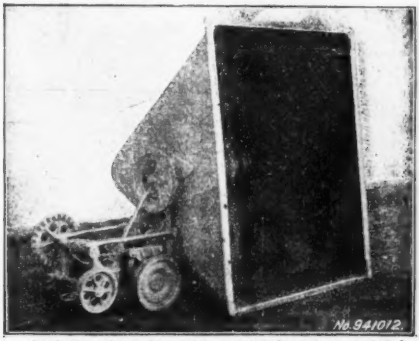

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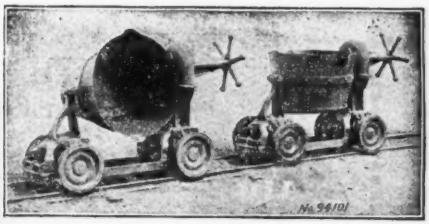

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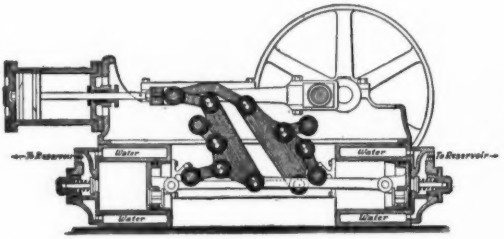

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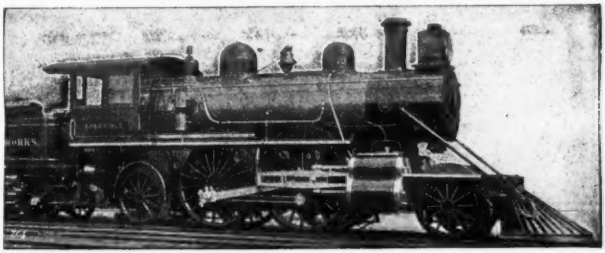

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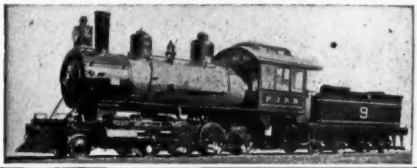

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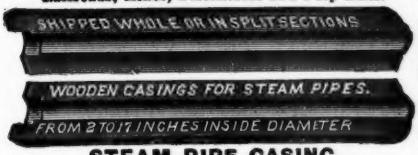

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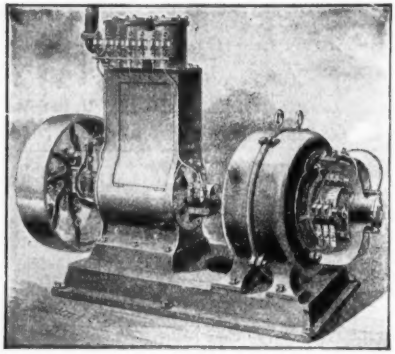

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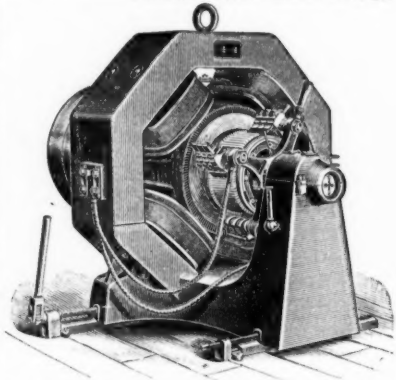

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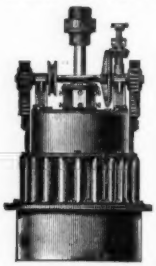

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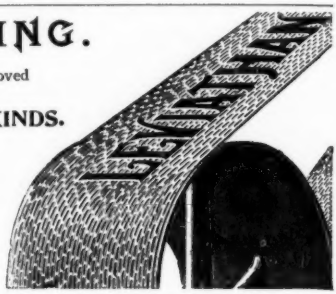

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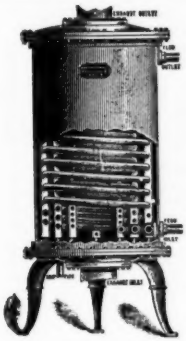

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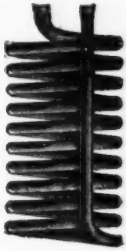

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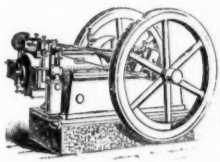

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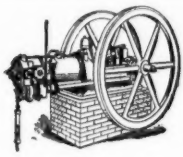

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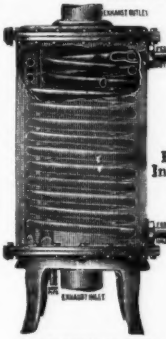

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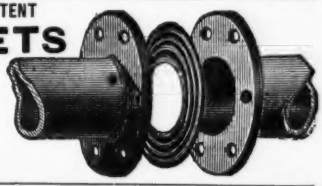

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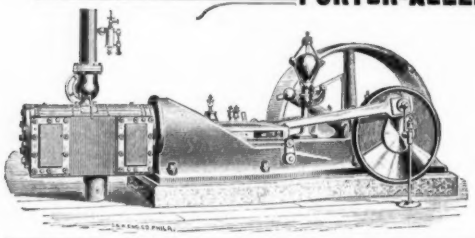

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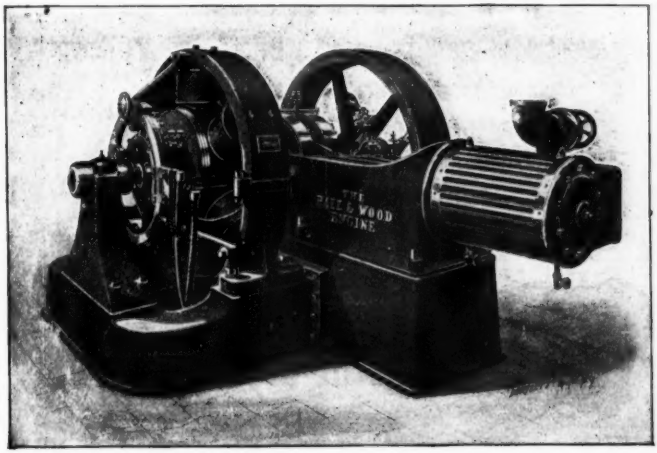

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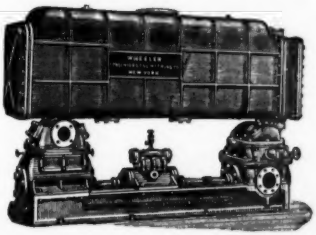

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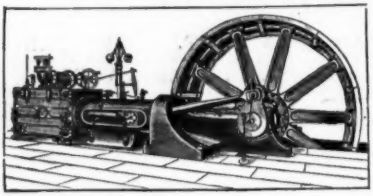

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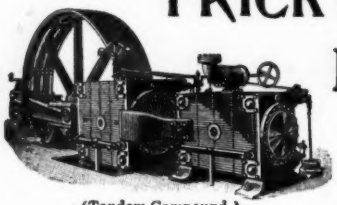

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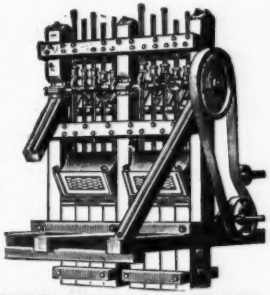

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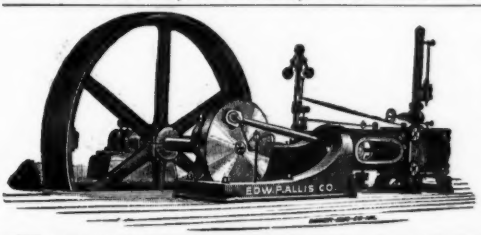

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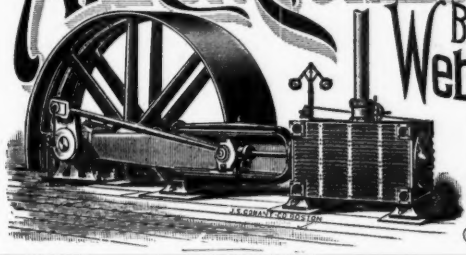

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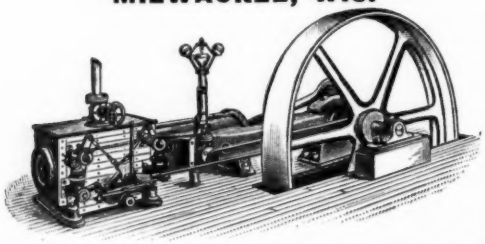

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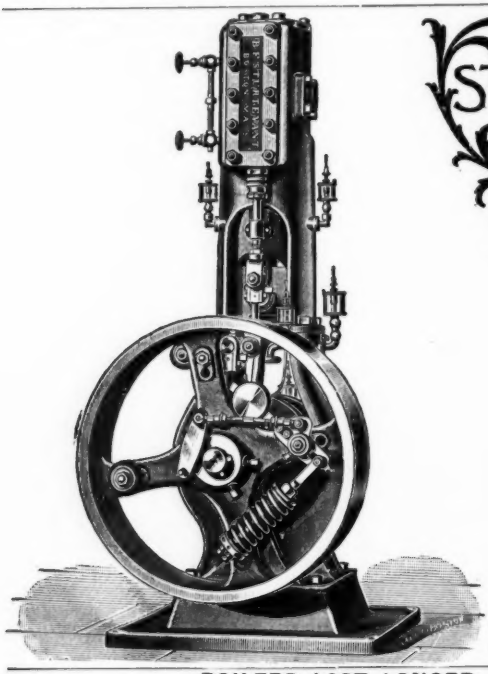

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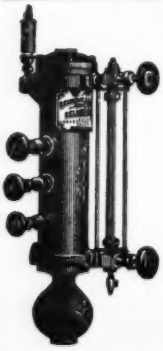

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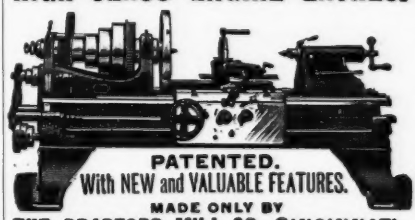

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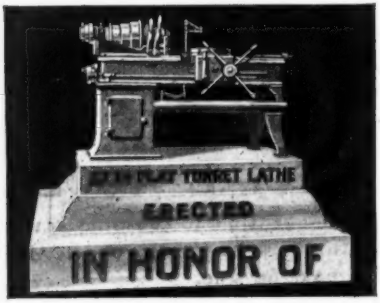

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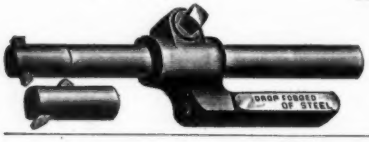

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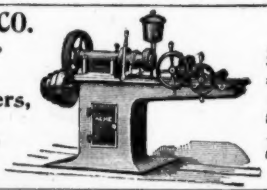

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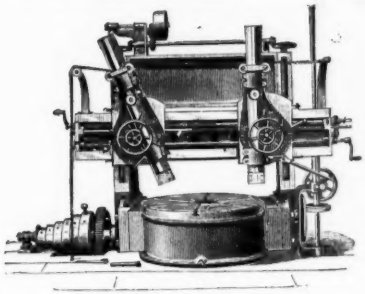

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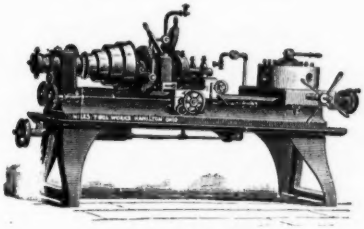

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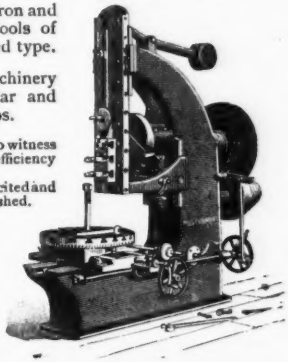

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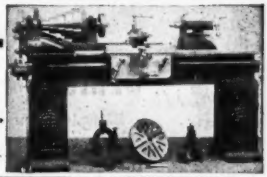

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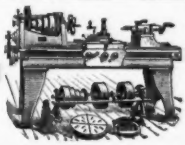

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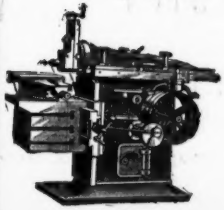

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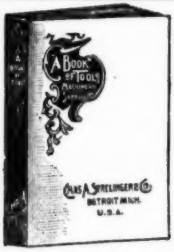

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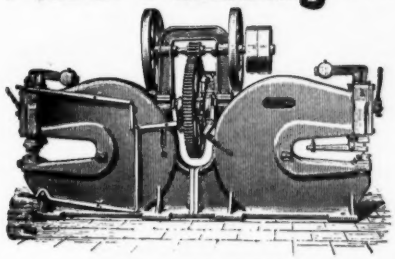

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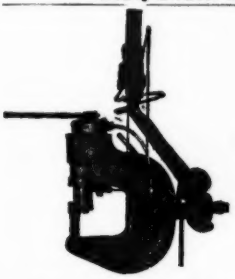

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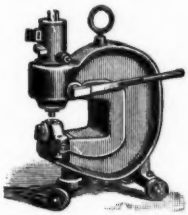

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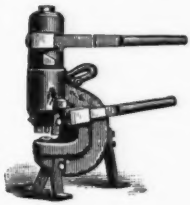

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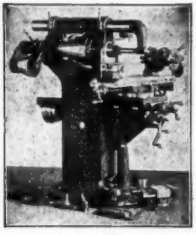

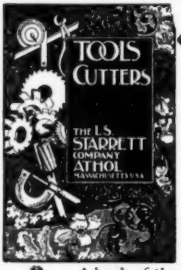

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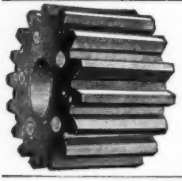

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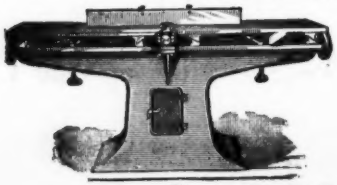

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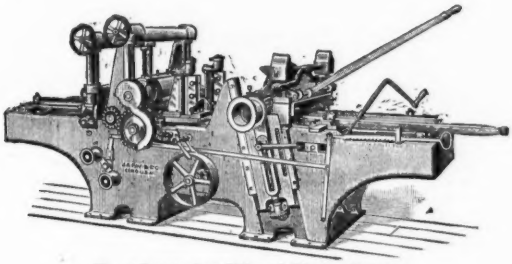

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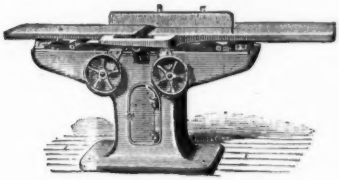

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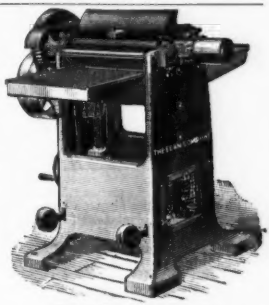

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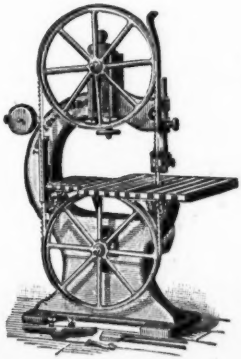

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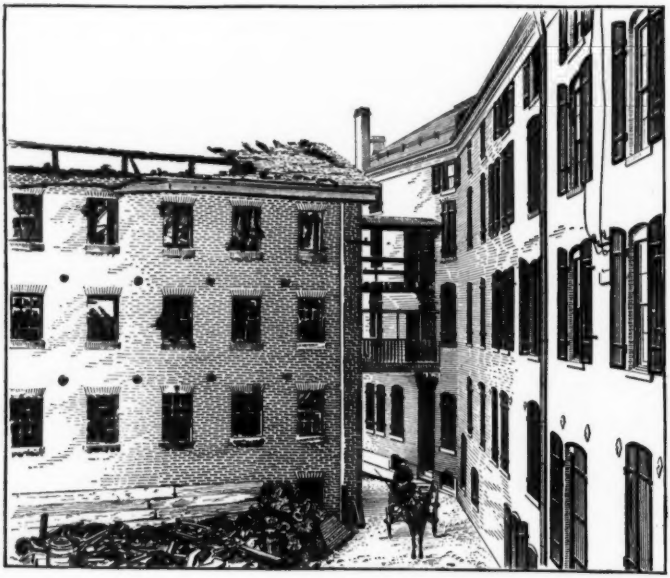

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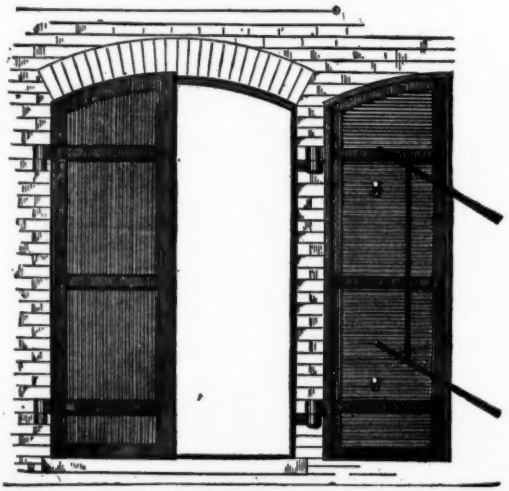

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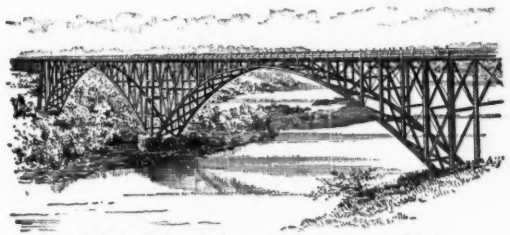

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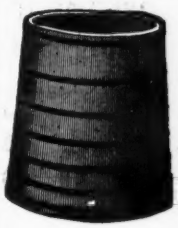

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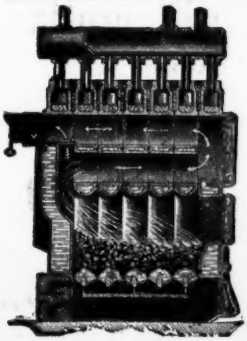

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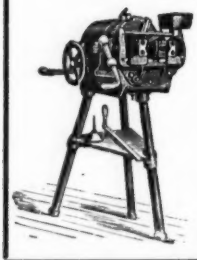

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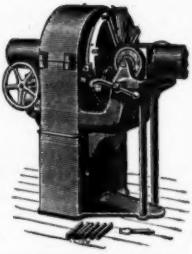

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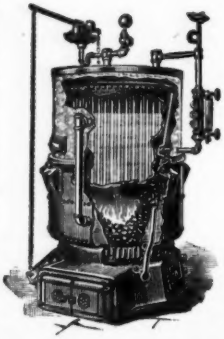

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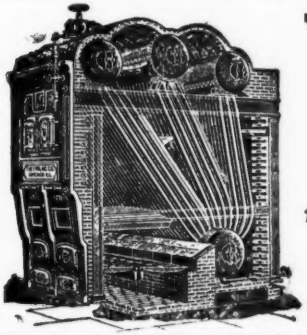

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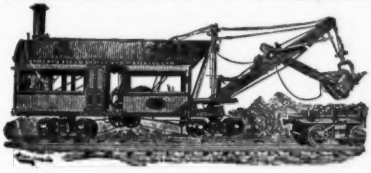

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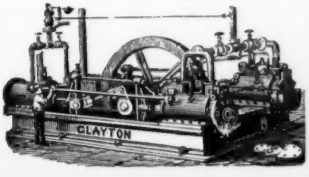

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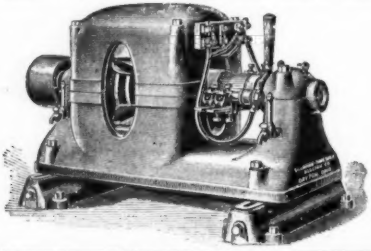

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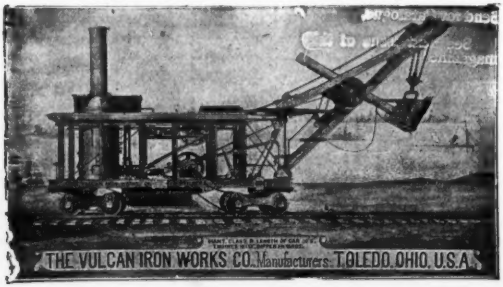

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AUTHORS AND PAPERS THIS MONTH.

J. SELWIN TAIT (*Free-Silver Poison the Cause of Industrial Paralysis*)=Educated in Scotland and learned banking in the British Linen Company Bank, one of the oldest and best banking institutions of Scotland; after went to London where he joined a large joint-stock bank; in 1869 appointed a branch manager of that bank (London & South Western Bank) and the number of branches under his charge was finally increased to six; for many years a Fellow of the Royal Literary Society of London; since residing in the United States has written extensively for the press on financial subjects, over his own signature, his contributions to the New York *Evening Post* being especially well known. Mr. Tait is the author of a *brochure*—now out of print—entitled "National Banks and Government Circulation," which attracted wide attention in 1888. Of an article written by Mr. Tait entitled "Iniquity of Free Coinage," President Cleveland has said that it was the clearest exposition of the situation that he had seen up to that time, 1891; is now at the head of the firm of Selwin Tait and Sons, publishers, New York city.

D. M. DUNNING (*Gas versus Electricity Direct from Coal*)=Graduated from Union College (Class of 1868) as civil engineer; engaged on railroad construction and as city surveyor of Auburn, N. Y., until 1870, when he succeeded his father as superintendent and treasurer of the Auburn Gas Light Company, which position he has since retained; has given his attention largely to agriculture and horticulture, in which line he is better known to the public than through the gas industry, having contributed to the horticultural press and to their societies, papers and various reports; he is, however, an enthusiastic and practical gas engineer, and has brought his company up to a high state of efficiency.

WM. BARCLAY PARSONS (*The Underground Topography of a City*)=Born in New York 15th April, 1859; graduated as A.B., Columbia, 1879, and as C.E., 1882; member of the American Society of Civil Engineers, of the Institution of Civil Engineers (London) and other scientific bodies; since 1880 he has had active experience in the construction and operation of railroads, and during the past ten years has devoted his attention largely to the problem of rapid transit in the city of New York, having served as engineer for several private companies who endeavored to solve the question in 1886-1889; as deputy-chief engineer of the Rapid Transit Commission of 1891, and as chief engineer of the Rapid Transit Commission of 1894, from its organization to the present time; he has made personal investigations into the questions of rapid transit in other cities of the United States and Europe, the results of which were embodied in a report to the Rapid Transit Commission; he is also the author of several books and engineering papers.

THOMAS TONGE (*The Less-Known Gold Fields of Colorado*)=Born at Styal, near Manchester, England, in which city, while connected with the legal profession from 1864 to 1883, he did very considerable journalistic work for the Manchester and other papers, including special articles on the English Land Question, the Irish Land Question and other then current topics; in 1883, by the advice of his physician, he moved to Denver, Colorado, where he became an American citizen without loss of time; since 1883 he has made a special study of questions affecting Colorado and the trans-Missouri States, on which he has for years past been regarded as one of the leading, best informed and most reliable authorities; during his residence in Denver he has been a frequent contributor to the columns of the local, eastern and British press, and for some time past has acted as Colorado correspondent of several important British papers.

DR. CHARLES E. EMERY (*The Problem of Boiler Selection*)=Born March 29, 1838, at Aurora, N. Y.; practiced land-surveying and learned the use of tools in a shop in youth; dur-

ing the war, in engineer corps of the U. S. navy, participated in engagements on the Mississippi river and in operations off Charleston, and subsequently on experimental duty in New York till the close of the war; consulting engineer of the U. S. Coast Survey and U. S. Revenue Marine Service for about 21 years, and made experiments with compound and non-compound engines published all over the world; received the honorary degree of Doctor of Philosophy soon after; built the plant of the Steam Company in New York—(cost nearly $2,000,000)—resigning in 1887; at present, practicing as consulting engineer and as expert in cases relating to the condemnation of water-power and important patent-suits; juror of group XX, Centennial Exhibition, prime movers and motors of all kinds, and a judge in the Department of Electricity of the Columbian Exposition.

H. T. NEWCOMB (*Railway Pooling and the Reduction of Freight Rates*)=Born at Owasso, Michigan, January 4, 1867; fourteen years later graduated from Ludington (Mich.) High School; entered railway service January, 1882, in general offices of Chicago, Milwaukee & St. Paul Railway, then at Milwaukee; March, 1888, accepted position in Bureau of Rates and Transportation of the Interstate Commerce Commission; while in latter employment studied law evenings and was graduated from the Law Department of Columbian University in 1891, receiving degree of L.L. M. from same institution in 1892; in March, 1895, was appointed chief of the freight rate section in the division of Statistics, United States Department of Agriculture; is a member of the bar of the Supreme Court of the District of Columbia and of numerous societies, and a wide contributor to economic and general literature.

GEORGE HERBERT STOCKBRIDGE (*The Shifting Lines of Industrial Interest in Electricity*)=Born at Mexico, Oxford Co., Maine; educated at Bates College and Leipzig University; was for several years a teacher in high schools and preparatory schools in Maine and Vermont, and afterwards taught at Amherst and Johns Hopkins; entered the United States Patent Office in 1881 and remained there three years, being most of the time an examiner in the Electrical Division; since 1884 has been a patent solicitor, formerly in Washington and at present in New York, and has served as an expert in a number of important suits relating to electrical and mechanical inventions. Mr. Stockbridge has been a contributor to various literary and scientific periodicals, including the *New England Magazine*, *Belford's Magazine*, the *Electrical Engineer*, the *Electrical World*, and many others.

DOWNING VAUX (*The Harmony of Architecture and Landscape Work*)=Born in New York City Nov. 14, 1856; attended public and private schools in New York and Plymouth, Mass., and the School of Mines, Columbia College, N. Y.; began work with a firm of engineers in New York City, spent a year with a plaster Co. in New Brunswick, Canada, while a railroad was being built to their quarry; associated with his father, Calvert Vaux, for some years on architectural and landscape work both in New York and through the country; draughtsman in Department Public Works, N. Y., for several years; for the last 9 years, a practicing architect and landscape architect in New York City; has lectured several years in the University of New York, on landscape architecture; has been engaged lately on work at Niagara Falls, Middletown Park, Downing Park, Newburgh, N. Y., park at St. John, Canada, and many private grounds; a critical student of park work both in this country and abroad.

H. L. ARNOLD (*Modern Machine Shop Economics*)=Born near Rochester, N. Y., June 25, 1837; worked as a journeyman machinist in western river and lake engine shops and R. I. R. R. shops for twelve years; subsequently superintendent Ottawa Machine Shops and Foundry, Ottawa, Ill., designer and department foreman for E. W. Bliss, Brooklyn, N. Y., superintendent for Stiles and Parker Press Company, Middletown, Conn., and designer for Pratt and Whitney Company, Hartford, Conn.; a frequent, able, and acceptable contributor to *American Machinist*, and other American publications devoted to mechanics.

H. K. LANDIS (*The Manufacture and Use of Brick for Paving*)=Born Lancaster, Pa., Aug. 9, 1865; graduated from Lehigh University as Bachelor of Science 1890 and Engineer of Mines 1891; assistant to Supt. Bethlehem Iron Co. in armor and ordnance work; engineer for the Lehigh Zinc and Iron Co.; Professor of Mining and Metallurgy, School of Mines of the University of Missouri; on the editorial staff of "The Mineral Industry" for 1894; on the editorial staff of THE ENGINEERING MAGAZINE; at present dealer in mining properties. Member of the A. I. M. E., American Chemical Society, North of England Institution of Mining and Mechanical Engineers, and a frequent contributor to technical literature.

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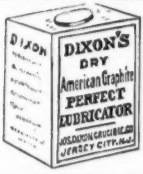

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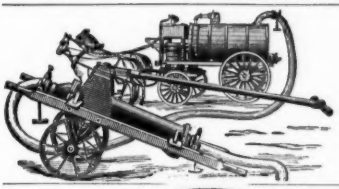

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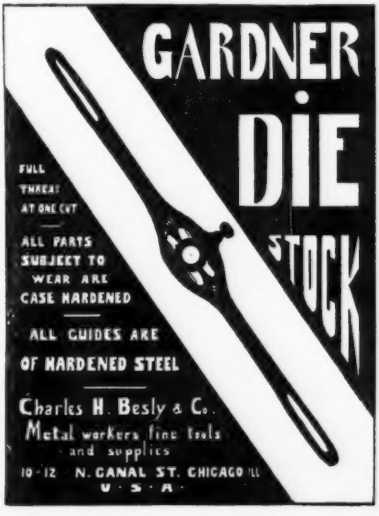
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201 PERRY-PAYNE BLDG., CLEVELAND, O.

Referring to THE ENGINEERING MAGAZINE, the Cambridge and Guernsey Consolidated Fuel Co., of Cambridge, Ohio, write:

"Permit us in passing to congratulate you upon the character of the journal you are producing."

A Buyers Directory

of

The Engineering Trades.

NOTE.—*The display advertisements of the firms mentioned under each heading can be found readily by reference to the Alphabetical Index on page 21.*

Acid Works Castings.

Addyston Pipe & Steel Co., Cincinnati, Ohio.
Phosphor-Bronze Smelting Co., Lt., Phila., Pa.
WheelerCondenser & Eng. Co., 39 Cortlandt St., N.Y.

Advertising Experts.

Manufacturers' Advertising Bureau, 111 Liberty St., New York.

Air Compressors.

American Well Works, Aurora, Ill.
Edw. P. Allis Co., Milwaukee, Wis.
M. C. Bullock Mfg. Co., Chicago, Ill.
Clayton Air Compressor Wks, 26 Cortlandt St., N.Y.
Filer & Stowell Co., Milwaukee, Wis.
Gates Iron Works, Chicago, Ill.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
New York Air Brake Co., 66 Broadway, N. Y.
Norwalk Iron Works, South Norwalk, Conn.
Rand Drill Co., 100 Broadway, N. Y.
Sullivan Machinery Co., Chicago, Ill.

Anti Friction Metals.

Phosphor Bronze Smelting Co., Ltd., Phila., Pa.

Architectural Iron.

Addyston Pipe and Steel Co., Cincinnati, Ohio.
Berlin Iron Bridge Co., East Berlin, Conn.
Riter & Conley, Pittsburg, Pa.
The Continental Iron Works, Brooklyn, N. Y.
Passaic Rolling Mill Co., Paterson, N. J.
Wheeling Corrugating Co., Wheeling, W. Va.
Winslow Bros. Co., Chicago, Ill.
Wrought Iron Bridge Co., Canton, Ohio.

Architectural Sheet Metal Work.

Cincinnati Corrugating Co., Piqua, Ohio.
Wheeling Corrugating Co., Wheeling, W. Va.

Ballast Unloaders.

Marion Steam Shovel Co., Marion, Ohio.

Baths.

Standard Manufacturing Co., Pittsburg, Pa.

Belt Dressing.

Jos. Dixon Crucible Co., Jersey City, N. J.

Belting.

Boston Belting Co., Boston, Mass.
Home Rubber Co., Trenton, N. J.
Main Belting Co., Philadelphia, Pa.
N. J. Car Spring & Rubber Co., Jersey City, N. J.
New York Belting & Packing Co., Ltd., New York.

Belt Lacing.

Bristol Co., Waterbury, Conn.

Bicycles

Gladiator Cycle Works, Chicago, Ill.
Pope Mfg. Co., Hartford, Conn.

Blacksmiths' Tools.

Buffalo Forge Co., Buffalo, N. Y.

Blast Furnaces.

Maryland Steel Co., Sparrows Point, Md.

Blast Furnaces, Gas.

American Gas Furnace Co., Elizabeth, N. J.

Blowers.

American Blower Co., Detroit, Mich.
American Gas Furnace Co., Elizabeth, N. J.
Buffalo Forge Co., Buffalo, N. Y.
Connersville Blower Co., Connersville, Ind.
B. F. Sturtevant Co., Boston, Mass.
Gates Iron Works, Chicago, Ill.

Boilers.

American Well Works, Aurora, Ill.
Atlantic Works, East Boston, Mass.
Edw. P. Allis Co., Milwaukee, Wis.
Clonbrock Steam Boiler Co., Brooklyn, N. Y.
Colorado Iron Works, Denver, Colo.
Buckeye Engine Co., Salem, Ohio.
H. E. Collins & Co., Pittsburg, Pa.
Continental Iron Works, Brooklyn, N. Y.
Gates Iron Works, Chicag , Ill.
The Hazelton Boiler Co., 716 E. 13th St., New York.
Heine Safety Boiler Co., St. Louis, Mo.
Maryland Steel Co., Sparrows Point, Md.
Mundy, J. S., Newark, N. J.
New York Central Iron Works Co., Geneva, N. Y.
Pittsburg Locomotive Works, Pittsburg, Pa.
Riter & Conley, Pittsburg, Pa.
Southwark Foundry and Machine Co., Phila., Pa.
Stirling Co., Chicago, Ill.
Robt. Wetherill & Co., Chester, Pa.

Boiler Fronts and Fittings.

New York Central Iron Works Co., Geneva, N. Y.
Reliance Gauge Co., Cleveland, Ohio.
Riter & Conley, Pittsburg, Pa.
Vulcan Iron Works, Toledo, Ohio.

Boiler Inspectors.

Hartford S. B. I. & Ins. Co., Hartford, Conn.

Bolt Cutters.

Acme Machinery Co., Cleveland, Ohio.

Bolt and Rivet Headers.

Acme Machinery Co., Cleveland, Ohio.

Boring Machines.

Lodge & Shipley Machine Tool Co., Cincinnati, O.

For Alphabetical Index to Advertisers, see page 21.

Bricks.

Empire Fire-Proofing Co., Pittsburg, Pa.
Henry Maurer & Son, 420 E. 23d St., N. Y.
Pittsburg Terra Cotta Lumber Co, Pittsburg, Pa.

Brick and Tile Machinery.

F. D. Cummer & Son Co., Cleveland, Ohio.
Harrington & King Perforating Co., Chicago, Ill.
Jeffrey Mfg. Co. Columbus, Ohio.
New York Central Iron Works Co., Geneva, N. Y.

Bridge Builders.

Berlin Iron Bridge Co., East Berlin, Conn.
The Continental Iron Works, Brooklyn, N. Y.
Maryland Steel Co., Sparrows Point, Md.
Passaic Rolling Mill Co., Paterson, N. J.
Riter & Conley, Pittsburg, Pa.
Wrought Iron Bridge Co., Canton, Ohio.

Builders' Elevators.

John F. Byers Machine Co., Ravenna, Ohio.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.

Building Materials.

Berlin Iron Bridge Co., East Berlin, Conn.
T. H. Brooks & Co., Cleveland, Ohio.
Cincinnati Corrugating Co., Piqua, Ohio.
Detroit Graphite Mfg. Co., Detroit, Mich.
Edward Smith & Co., 45 Broadway, New York.
Empire Fire-Proofing Co., Pittsburg, Pa.
Henry Maurer & Son, 420 E. 23d St., N. Y.
Joseph Dixon Crucible Co., Jersey City, N. J.
Maryland Steel Co., Sparrows Point, Md.
N. & G. Taylor Co., Philadelphia, Pa.
Passaic Rolling Mill Co., Paterson, N. J.
Pittsburg Terra Cotta Lumber Co, Pittsburg, Pa.
Riter & Conley, Pittsburg, Pa.
Translucent Fabric Co., Boston, Mass.
Wheeling Corrugating Co., Wheeling, W. Va.
Winslow Bros. Co., Chicago, Ill.
Wrought Iron Bridge Co., Canton, Ohio.

Cable Railways.

Robert Poole & Son Co., Baltimore, Md.

Cable Railway Driving Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
Robt. Wetherill & Co., Chester, Pa.

Cables, Electric and Submarine.

Eastern Electric Cable Co., Boston, Mass.
The Okonite Co., Ltd., 13 Park Row, N. Y.

Cableways.

Lidgerwood Mfg. Co., 96 Liberty St., N. Y.

Cables, Wire.

Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
H. Channon Company, Chicago, Ill.
John A. Roebling's Sons Co., Trenton, N. J.
Trenton Iron Co., Trenton, N. J.

Calcining and Drying Machines.

F. D. Cummer & Son Co., Cleveland, Ohio.

Calipers and Dividers.

L. S. Starrett, Athol, Mass.

Cams and Tappets.

Chrome Steel Works, Brooklyn, N. Y.

Carpenters' Tools.

L. S. Starrett, Athol, Mass.

Carriage and Wagon Machinery.

Buffalo Forge Co., Buffalo, N. Y.
C. B. Rogers & Co., Norwich, Conn.
J. A. Fay & Egan Co., Cincinnati, Ohio.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Castings, Iron and Steel.

Addyston Pipe & Steel Co., Cincinnati, Ohio.
Edw. P. Allis Co., Milwaukee, Wis.
Brown & Sharpe Mfg. Co., Providence, R. I.
Berlin Iron Bridge Co., East Berlin, Conn.
Buffalo Forge Co., Buffalo, N. Y.
Chrome Steel Works, Brooklyn, N. Y.
Filer & Stowell Co., Milwaukee, Wis.
Gates Iron Works, Chicago, Ill.
Maryland Steel Co., Sparrows Point, Md.
McNeal Pipe and Foundry Co., Burlington, N. J.
New York Central Iron Works Co., Geneva, N. Y.
Ohio Pipe Co., Columbus, Ohio.
Riter & Conley, Pittsburg, Pa.
Robert Poole & Son Co., Baltimore, Md.
Wheeler Condenser & Eng. Co., 39 Cortlandt St., N.Y.
R. D. Wood & Co., Philadelphia, Pa.

Cement.

Atlas Cement Co., 143 Liberty St., New York.
New York & Rosendale Cement Co., 280 Broadway, N. Y.

Chain Belting.

Jeffrey Mfg. Co., Columbus, Ohio.
Link Belt Engineering Co., Philadelphia, Pa.

Chemical Works Machinery.

Wheeler Condenser & Eng. Co., 39 Cortlandt St., N.Y.
R. D. Wood & Co., Philadelphia, Pa.

Chucks (All Purposes).

Morse Twist Drill & Machine Co., New Bedford, Mass.
Standard Tool Co., Cleveland, Ohio.

Clay Working Machinery.

W. J. Clark & Co., Salem, Ohio.
F. D. Cummer & Son Co., Cleveland, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Vulcan Iron Works, Toledo, Ohio.

Closets.

Standard Manufacturing Co., Pittsburg, Pa.

Clutches, Friction.

J. S. Mundy, Newark, N. J.
Robert Poole & Son Co., Baltimore, Md.

Coal Mining Machinery.

Buffalo Forge Co., Buffalo, N. Y.
W. J. Clark & Co., Salem, Ohio.
W. A. Crook & Bros. Co., Newark, N. J.
General Electric Co., 44 Broad St., New York.
C. W. Hunt, Co., 45 Broadway, N. Y.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Rand Drill Co., 100 Broadway, N. Y.
Sullivan Machinery Co., Chicago, Ill.

For Alphabetical Index to Advertisers, see page 21.

Concentrators and Pulverizers.

Bradley Pulverizer Co., Boston, Mass.
Colorado Iron Works, Denver, Colo.
F. D. Cummer & Son Co., Cleveland, Ohio.
Gates Iron Works, Chicago, Ill.
Sturtevant Mill Co., Boston. Mass.

Condensers.

Edw. P. Allis Co., Milwaukee, Wis.
Deane Steam Pump Co., Holyoke, Mass
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
Southwark Foundry and Machine Co., Phila., Pa.
Wheeler Condenser & Eng. Co., 39 Cortlandt St., N. Y.

Consulting Engineers.

Alton D. Adams, Worcester, Mass.
D. Ashworth, Pittsburg, Pa.
Wm. H. Bryan, St. Louis, Mo.
Blood & Hale, Boston, Mass.
C. M. Conradson, Madison, Wis.
Croze & Dengler, Denver, Colo.
Dr. Willis E. Everette, Tacoma, Wash.
M. Fargusson, Southport, N. C.
C. T. Gooding, Tucson, Ariz.
E. B. Hussey, Seattle, Wash.
E. P. Jennings, Ironwood, Mich.
Julian Kennedy, Pittsburg, Pa.
Frank Nicholson, Phoenix, Ariz.
Pittsburg Testing Lab'y, Ltd., Pittsburg, Pa.
Alexander Potter, New York and Pittsburg.
C. L. Redfield, Chicago, Ill.
Vandenbergh Lab'y of Chem. Ind., Buffalo, N. Y.
Wm. O. Webber, Boston, Mass.

Contractors' Dump Cars, etc.

Gates Iron Works, Chicago, Ill.

Contractors' Supplies.

John F. Byers Machine Co., Ravenna, Ohio.
Thomas Carlin's Sons, Allegheny, Pa.
H. Channon Company, Chicago, Ill.
Colorado Iron Works, Denver, Colo.
Contractors' Plant Mfg. Co., Buffalo, N. Y.
W. A. Crook & Bros. Co., Newark, N. J.
Jeffrey Mfg. Co., Columbus, Ohio.
Link-Belt Engineering Co., Phila., Pa.
J. S. Mundy, Newark, N. J.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Vulcan Iron Works, Toledo, Ohio.
Watson & Stillman Co., 210 E. 43d St., New York.

Conveying Machinery.

W. J. Clark & Co., Salem, Ohio.
Frick Company, Waynesboro, Pa.
C. W. Hunt Co., 45 Broadway, N. Y.
Jeffrey Mfg. Co., Columbus, O.
John A. Roebling's Sons Co., Trenton, N. J.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
Link-Belt Engineering Co., Phila., Pa.

Copper.

Canadian Copper Co., Cleveland, O.

Corrugated Iron.

Berlin Iron Bridge Co., East Berlin, Conn.
Wheeling Corrugating Co., Wheeling, W. Va.

Cranes.

Addyston Pipe & Steel Co., Cincinnati, Ohio
Berlin Iron Bridge Co., East Berlin, Conn.
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Wm. Sellers & Co., Philadelphia, Pa.
Walker Manufacturing Co., Cleveland, Ohio.
R. D. Wood & Co., Philadelphia, Pa.

Crusher Plates.

Chrome Steel Works, Brooklyn, N. Y.
Gates Iron Works, Chicago, Ill.

Crushers, Ore, Phosphate, Rock

Edw. P. Allis Co., Milwaukee, Wis.
Bradley Pulverizer Co., Boston, Mass.
Colorado Iron Works, Denver, Colo.
Gates Iron Works, Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.
Chrome Steel Works, Brooklyn, N. Y.
Sturtevant Mill Co., Boston. Mass.

Diamond Drills.

American Well Works, Aurora, Ill.
M. C. Bullock Mfg. Co., Chicago, Ill.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y
Sullivan Machinery Co., Chicago, Ill.
Rand Drill Co., 100 Broadway, N. Y.

Dies and Die Forgings.

Morse Twist Drill & Machine Co., New Bedford, Mass

Die and Drill Steel.

Chrome Steel Works, Brooklyn, N. Y.
Wm. Jessop & Sons, Limited, 91 John St., N. Y.

Drawing Instruments.

Theo. Alteneder & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.
Keuffel & Esser Co., 127 Fulton St., New York.
Queen & Co., Philadelphia, Pa.
L. S. Starrett, Athol, Mass.

Dredging Contractors.

Babcock-Lary Dredging Co., 29 Broadway, N. Y.

Dredging Machines.

Babcock-Lary Dredging Co., 29 Broadway, N. Y.
W. J. Clark & Co., Salem, Ohio.
J. S. Mundy, Newark, N. J.
Marion Steam Shovel Co., Marion, Ohio.
Maryland Steel Co., Sparrows Point, Md.
New York Dredging Co., 61 Park Row, N. Y.
Robert Poole & Son Co., Baltimore, Md.
Vulcan Iron Works, Toledo, Ohio.

Drills, Rock and Coal.

M. C. Bullock Mfg. Co., Chicago, Ill.
General Electric Co., 44 Broad St., New York.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Rand Drill Co., 100 Broadway, N. Y.
Sullivan Machinery Co., Chicago, Ill.

Drilling Machines.

W. F. & John Barnes Co., Rockford, Ill.
Buffalo Forge Co., Buffalo, N. Y.
Davis & Egan Machine Tool Co., Cincinnati, Ohio.
Lodge & Shipley Machine Tool Co., Cincinnati, O.
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Niles Tool Works, Hamilton, Ohio.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

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Drop Hammers.

Stiles & Fladd Press Co., Watertown, N. Y.

Drying and Calcining Machines.

American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
Colorado Iron Works, Denver, Colo.
F. D. Cummer & Son Co., Cleveland, Ohio.
Gates Iron Works, Chicago, Ill.
Maryland Steel Co , Sparrows Point, Md.

Dynamos.

H. B Coho & Co., 203 Broadway, New York.
Eddy Electric Manufacturing Co., Windsor, Conn.
Fort Wayne Electric Corporation, Fort Wayne, Ind.
General Electric Co., 44 Broad St., New York.
Interior Conduit & Insulation Co., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
J. H. McEwen Mfg. Co., Dey St., N. Y.
Thresher Electric Co., Dayton, O.
Westinghouse Electric & Mfg. Co., Pittsburgh, Pa.

Electrical Machinery and Supplies.

Bristol Co., Waterbury, Conn.
H. B. Coho & Co., 203 Broadway, New York.
Eddy Electric Manufacturing Co., Windsor, Conn.
Fort Wayne Electric Corporation, Fort Wayne, Ind.
General Electric Co., 44 Broad St., New York.
Interior Conduit & Insulation Co., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
J. H. McEwen Mfg. Co., Dey St., N. Y.
Queen & Co., Inc., Philadelphia, Pa.
Wm. E. Quimby, 59 Liberty St., New York.
Thresher Electric Co., Dayton, O.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.
Weston Electrical Instrument Co., Newark, N. J.

Electric Locomotives.

Baldwin Locomotive Works, Philadelphia, Pa.
General Electric Co., 44 Broad St., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
H K. Porter & Co., Pittsburg, Pa.

Electroplating and Electrotyping Machines.

Eddy Electric Manufacturing Co., Windsor, Conn.

Elevator Buckets.

W. J. Clark & Co., Salem, Ohio.

Elevator Guards and Screens.

Harrington & King Perforating Co., Chicago, Ill.

Elevators (All kinds).

Gates Iron Works. Chicago, Ill.

Emery Wheels.

New York Belting & Packing Co., Ltd., New York.
Sterling Emery Wheel Mfg. Co., Tiffin, Ohio.

Emery Wheel Machinery.

Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.

Engineering Instruments.

Theo Alteneder & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.
Keuffel & Esser Co., 127 Fulton St., New York.
Queen & Co., Inc., Philadelphia, Pa.

Engines, Blowing.

Edw. P. Allis Co., Milwaukee, Wis.
Southwark Foundry and Machine Co., Phila., Pa.
Walker Manufacturing Co., Cleveland, Ohio.

Engine Governors.

J. H. McEwen Mfg. Co., Dey St., N. Y.

Engines, Gas, Gasoline, and Petroleum.

American Well Works, Aurora, Ill.
Otto Gas Engine Works, Philadelphia, Pa.
Springfield Gas Engine Co., Springfield, Ohio.

Engines, Marine.

Atlantic Works, East Boston, Mass.
Marine Iron Works, Chicago, Ill.
Maryland Steel Co., Sparrows Point, Md.
New York Central Iron Works Co., Geneva, N. Y.

Engines, Stationary.

American Well Works, Aurora, Ill.
Edw. P. Allis Co., Milwaukee, Wis.
Ball & Wood Co., 15 Cortlandt St., New York.
Buckeye Engine Co., Salem, Ohio.
Buffalo Forge Co., Buffalo, N. Y.
M. C. Bullock Mfg. Co., Chicago, Ill.
John F. Byers Machine Co., Ravenna, Ohio.
Colorado Iron Works, Denver, Colo
Filer & Stowell Co., Milwaukee, Wis.
Fishkill Landing Machine Co., Fishkill, N. Y.
Frick Company, Waynesboro, Pa.
Gates Iron Works, Chicago, Ill.
Hooven, Owens & Rentschler Co., Hamilton, Ohio.
J. H. McEwen Mfg. Co., Dey St., N. Y.
Maryland Steel Co., Sparrows Point, Md.
New York Central Iron Works Co., Geneva, N. Y.
Southwark Foundry and Machine Co., Phila., Pa.
Stearns Manufacturing Co., Erie, Pa.
B. F. Sturtevant Co., Boston, Mass.
Westinghouse Machine Co., Pittsburg, Pa.
Webster, Camp & Lane Machine Co., Akron, Ohio.
Robert Wetherill & Co., Chester, Pa.

Evaporators.

Wheeler Condenser & Eng. Co., 39 Cortlandt St., N. Y.

Excavators.

Jeffrey Mfg. Co., Columbus, Ohio.
Marion Steam Shovel Co., Marion, Ohio.
New York Dredging Co., 61 Park Row, New York.
Vulcan Iron Works, Toledo, Ohio.

Fans, Ventilating.

Buffalo Forge Co., Buffalo, N. Y.
M. C. Bullock Mfg. Co., Chicago, Ill.

Feed-Water Heaters.

Edw. P. Allis Co., Milwaukee, Wis.
Goubert Mfg. Co., 14 Church St., N. Y.
National Pipe Bending Co., New Haven, Conn.
Robt. Wetherill & Co., Chester, Pa.
Wheeler Condenser & Eng Co., 39 Cortlandt St., N. Y.

Fertilizer Machinery.

Bradley Pulverizer Co., Boston, Mass.
Jeffrey Mfg. Co., Columbus, Ohio.
Robert Poole & Son Co., Baltimore, Md

Files.

Nicholson File Co., Providence, R. I.

Filters.

Continental Filter Co., 44 Wall St., New York.

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Morison-Jewell Filtration Co., 26 Cortland St., N.Y.
Wheeler Condenser & Eng. Co., 39 Cortlandt St., N.Y.

Flexible Shafts.

Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.

Floor and Sidewalk Lights.

T. H. Brooks & Co., Cleveland, Ohio.

Flour Mill Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
W. J. Clark & Co., Salem, Ohio.
Robert Poole & Son Co., Baltimore, Md.

Fly Wheels.

Edw. P. Allis Co., Milwaukee, Wis.
Robert Poole & Son Co., Baltimore, Md.

Forges.

Buffalo Forge Co., Buffalo, N. Y.

Furnace Builders.

Julian Kennedy, Pittsburg, Pa.
Riter & Conley, Pittsburg, Pa.

Furniture, Office.

The Globe Co., Cincinnati, Ohio.

Furniture and Chair Machinery.

J. A. Fay & Egan Co., Cincinnati, Ohio.
C. B. Rogers & Co., Norwich, Conn.

Gages, Pressure, Steam, Water, etc.

Bristol Co., Waterbury, Conn.
Crane Company, Chicago, Ill.
The Fairbanks Co., New York.

Gas Machines and Generators.

American Gas Furnace Co., Elizabeth, N. J.

Gas Plants.

American Gas Furnace Co., Elizabeth, N. J.

Gas Works Machinery.

Continental Iron Works, Brooklyn, N. Y.
R. D. Wood & Co., Philadelphia, Pa.

Gaskets, Copper.

U. S. Mineral Wool Co., 2 Cortlandt St., N. Y.

Gate Valves.

Continental Iron Works, Brooklyn, N. Y.
Crane Company, Chicago, Ill.
Jenkins Brothers, 71 John St., N. Y.
The Fairbanks Co., New York.
Lunkenheimer Co., Cincinnati, Ohio.

Gear Cutters.

Brown & Sharpe Mfg. Co., Providence, R. I.
Standard Tool Co., Cleveland, Ohio.

Gearing.

Edw. P. Allis Co., Milwaukee, Wis.
Brown & Sharpe Mfg. Co., Providence, R. I.
New Process Rawhide Co., Syracuse, N. Y.
New York Central Iron Works Co., Geneva, N. Y.
Robert Poole & Son Co., Baltimore, Md.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.

Girders.

Berlin Iron Bridge Co., East Berlin, Conn.
Riter & Conley, Pittsburg, Pa.
Wrought Iron Bridge Co., Canton, Ohio.

Grain Elevator Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
W. J. Clark & Co., Salem, Ohio.
Jeffrey Mfg. Co., Columbus, Ohio.
Link Belt Engineering Co., Phila., Pa.
Robert Poole & Son Co., Baltimore, Md.

Grates.

Vulcan Iron Works, Toledo, Ohio.

Grinding and Polishing Machinery.

Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Machine Co., Cincinnati, Ohio.
Cleveland Twist Drill Co., Cleveland, Ohio.
Thomas Carlin's Sons, Allegheny, Pa.
Charles H. Besly & Co., Chicago, Ill.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Standard Tool Co., Cleveland, Ohio.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.

Grips, Cable Railways.

Robt. Wetherill & Co., Chester, Pa.

Hangers.

SEE PULLEYS, ETC.

Heating and Ventilating Apparatus.

American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
Connersville Blower Co., Connersville, Ind.
B. F. Sturtevant Co., Boston, Mass.

Heaters, Steam and Hot Water.

American Boiler Co., Chicago, Ill.
Gorton & Lidgerwood Co., 96 Liberty St., N. Y.
H. B. Smith Co., 137 Center St., N. Y.
New York Central Iron Works Co., Geneva, N. Y.
J. H. McLain & Co., Canton, Ohio.

Hoisting Engines and Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
M. C. Bullock Mfg. Co., Chicago, Ill.
John F. Byers Machine Co., Ravenna, Ohio.
Thomas Carlin's Sons, Allegheny, Pa.
H. Channon Company, Chicago, Ill.
Colorado Iron Works, Denver, Colo.
Contractors' Plant Mfg. Co., Buffalo, N. Y
Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
W. A. Crook & Bros. Co., Newark, N. J.
Gates Iron Works, Chicago, Ill.
C. W. Hunt Co., 45 Broadway, N. Y.
Jeffrey Mfg. Co., Columbus, Ohio.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Moore Mfg. & Foundry Co., Milwaukee, Wis.
J. S. Mundy, Newark, N. J.
Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton, N. J.
Webster, Camp & Lane Machine Co., Akron, Ohio.

Hollow Bricks.

Empire Fire-Proofing Co., Pittsburg, Pa.
Henry Maurer & Son, 420 E. 23d St., New York,
Pittsburg Terra Cotta Lumber Co., Pittsburg, Pa.

For Alphabetical Index to Advertisers, see page 21.

Hydraulic Cement.

Atlas Cement Co., 143 Liberty St., New York.
New York & Rosendale Cement Co., 280 Broadway, N. Y.

Hydraulic Machinery.

Maryland Steel Co., Sparrows Point, Md
Watson & Stillman Co., 210 E. 43d St., New York.
R. D. Wood & Co., Philadelphia, Pa.

Ice-Making Machinery.

Frick Company, Waynesboro, Pa.

Indicators, Steam-Engine.

Queen & Co., Inc., Philadelphia, Pa.

Injectors.

American Injector Co., Detroit, Mich.
Penberthy Injector Co., Detroit, Mich.
Wm. Sellers & Co., Philadelphia, Pa.

Industrial Railways.

C. W. Hunt Co., 45 Broadway, N. Y.

Insulated Wire.

W. R. Brixey, 203 Broadway, N. Y.
Eastern Electric Cable Co., Boston, Mass.
The Okonite Co., Ltd., 13 Park Row, N. Y.

Iron.

Passaic Rolling Mill Co., Paterson, N. J.

Joists, Iron and Steel.

Berlin Iron Bridge Co., East Berlin, Conn.
Passaic Rolling Mill Co., Paterson, N. J.
Riter & Conley, Pittsburg, Pa.
Wrought Iron Bridge Co., Canton, Ohio.

Kyanizing.

Otis Allen & Son, Lowell, Mass.

Lamps, Electric.

Fort Wayne Electric Corporation, Fort Wayne, Ind.
General Electric Co., 44 Broad St., New York.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Lathes.

W. F. & John Barnes Co., Rockford, Ill.
Bradford Mill Co., Cincinnati, Ohio.
Jones & Lamson Mch. Co., Springfield, Vt.
Davis & Egan Machine Tool Co., Cincinnati, Ohio.
Lodge & Shipley Machine Tool Co., Cincinnati, O.
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Niles Tool Works, Hamilton, Ohio.
Prentiss Tool and Supply Co., 115 Liberty St., N. Y.
Wm. Sellers & Co., Philadelphia, Pa.
The Wilkinson Co., Chicago, Ill.
The Wright Co., Lowell, Mass.

Locomotives.

Baldwin Locomotive Works, Philadelphia, Pa.
John F. Byers Machine Co. Ravenna, Ohio.
Thomas Carlin's Sons, Allegheny, Pa.
Pittsburg Locomotive Works Pittsburg, Pa.
H. K. Porter & Co., Pittsburg, Pa.

Locomotive Brakes.

Westinghouse Air Brake Co., Pittsburg, Pa.
New York Air Brake Co., 66 Broadway, N. Y.

Lubricants.

Jos. Dixon Crucible Co., Jersey City, N. J.

Lubricators.

Sherwood Mfg. Co., Buffalo, N. Y.
Lunkenheimer Co., Cincinnati, Ohio.

Machine Screws, etc.

Worcester Machine Screw Co., Worcester, Mass.

Machine Tools and Supplies.

Acme Machinery Co., Cleveland, Ohio.
Armstrong Bros. Tool Co., Chicago, Ill.
W. F. & John Barnes Co., Rockford, Ill.
Beaudry & Co., Boston, Mass.
Bradford Mill Co., Cincinnati, Ohio.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Machine Co., Cincinnati, Ohio.
Charles H. Besly & Co., Chicago Ill.
Cleveland Twist Drill Co., Cleveland, Ohio.
Ingersoll Milling Machine Co., Rockford, Ill.
Jones & Lamson Mch. Co., Springfield, Vt.
Davis & Egan Machine Tool Co., Cincinnati, Ohio.
Lodge & Shipley Machine Tool Co., Cincinnati, O.
Long & Allstatter Co., Hamilton, Ohio.
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Morse Twist Drill & Mach. Co., New Bedford, Mass.
Niles Tool Works, Hamilton, Ohio.
Robert Poole & Son Co., Baltimore, Md.
Q. & C. Co., Chicago, Ill.
C. B. Rogers & Co., Norwich, Conn.
Wm. Sellers & Co., Philadelphia, Pa.
Standard Tool Co., Cleveland, Ohio.
L. S. Starrett, Athol, Mass.
Stiles & Fladd Press Co., Watertown, N. Y.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Chas. A. Strelinger & Co., Detroit, Mich.
The Wilkinson Co., Chicago, Ill.
Worcester Machine Screw Co., Worcester, Mass.
The Wright Co., Lowell, Mass.

Marine Machinery.

W. A. Crook & Bros Co., Newark, N. J.

Mathematical Instruments.

Theo. Alteneder & Sons, Philadelphia, Pa.
Keuffel & Esser Co., 127 Fulton St., New York.
Queen & Co., Inc. Philadelphia, Pa.
L. S. Starrett, Athol, Mass.

Merchant Steel.

Wm. Jessop & Sons, Limited. 91 John St., N. Y

Metals.

Wm. Jessop & Sons, Ltd., 91 John St., N. Y.
Passaic Rolling Mill Co., Paterson, N. J.
Phosphor Bronze Smelting Co., Ltd., Phila., Pa.

Metal Lath.

Cincinnati Corrugating Co., Piqua, Ohio.

Metal Punching and Shearing.

Harrington & King Perforating Co., Chicago, Ill.

Metallurgical Supplies.

Colorado Iron Works, Denver, Colo.

Meters, Electric.

Fort Wayne Electric Corporation, Fort Wayne, Ind.

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General Electric Co., 44 Broad St., New York.
Weston Electrical Instrument Co., Newark, N. J.

Meters, Water.

Deane Steam Pump Co., Holyoke, Mass.
Union Water Meter Co , Worcester, Mass.

Milling Machines.

Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Machine Co., Cincinnati, Ohio.
Davis & Egan Machine Tool Co., Cincinnati, Ohio.

Mine Cars.

Colorado Iron Works, Denver, Colo.
Gates Iron Works, Chicago, Ill.

Mining Machinery

Bradley Pulverizer Co., Boston, Mass.
M. C. Bullock Mfg. Co., Chicago, Ill.
Chrome Steel Works, Brooklyn, N. Y.
W. J. Clark & Co., Salem, Ohio.
Colorado Iron Works, Denver, Colo.
W. A. Crook & Bros. Co., Newark, N. J.
A. S. Cameron Steam Pump Works, E. 23 N. Y.
Gates Iron Works, Chicago, Ill.
General Electric Co., 44 Broad St., New York.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N Y.
Jeffery Mfg. Co., Columbus, Ohio.
Lidgerwood Mfg. Co., 96 Liberty St., N. Y.
J. S. Mundy, Newark, N. J.
Rand Drill Co., 100 Broadway, N. Y.
Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton, N. J.
Webster, Camp & Lane Machine Co., Akron, Ohio.

Mining Screens.

Harrington & King Perforating Co., Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.

Motors, Electric.

H. B. Coho & Co., 203 Broadway, New York.
Eddy Electric Manufacturing Co., Windsor, Conn.
Fort Wayne Electric Corporation, Fort Wayne, Ind.
General Electric Co., 44 Broad St., New York.
Interior Conduit & Insulation Co., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
Thresher Electric Co., Dayton, O.
Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

Naphtha Gas Machines.

American Gas Furnace Co., Elizabeth, N. J.

Nickel.

Canadian Copper Co., Cleveland, O.

Oil Cups.

Lunkenheimer Co., Cincinnati, Ohio.

Oil Gas Plants.

American Gas Furnace Co., Elizabeth, N. J.

Ore Roasting Machinery.

Colorado Iron Works, Denver, Colo.
F. D. Cummer & Son Co., Cleveland, Ohio.
Gates Iron Works, Chicago, Ill.

Ornamental Iron Work.

Winslow Bros. Co., Chicago, Ill.

Packing

Boston Belting Co., Boston, Mass.
The Fairbanks Co., New York.
Jenkins Brothers, 71 John St., N. Y.
Manhattan Rubber Mfg. Co., 64 Cortlandt St., N. Y.
N. J. Car Spring & Rubber Co., Jersey, City, N. J.
New York Belting & Packing Co., Ltd., New York.

Paints.

Detroit Graphite Mfg. Co., Detroit, Mich.
Edward Smith & Co., 45 Broadway, New York.
Joseph Dixon Crucible Co., Jersey City, N. J.

Paper Mill Machinery.

Jeffrey Mfg. Co., Columbus, Ohio.
Robt. Wetherill & Co., Chester, Pa.

Penstocks.

Atlantic Works, East Boston, Mass.

Perforated Metals (All Kinds).

Harrington & King Perforating Co., Chicago, Ill.

Phosphor Bronze.

Phosphor Bronze Smelting Co., Ltd., Phila., Pa.

Photographic Supplies.

Queen & Co., Inc., Philadelphia, Pa.

Pipe, Cast Iron.

Addyston Pipe & Steel Co., Cincinnati, Ohio.
Jeanesville Iron Works, Jeanesville, Pa.
McNeal Pipe and Foundry Co., Burlington, N. J.
Ohio Pipe Co., Columbus, Ohio.
R. D. Wood & Co., Philadelphia, Pa.

Pipe, Coils and Bends.

National Pipe Bending Co., New Haven, Conn.

Pipe Coverings.

Michigan Pipe Co., Bay City, Mich.
New York Fireproof Covering Co., 42 Cortlandt St., N. Y.

Pipe Cutting and Threading Machines.

Armstrong Mfg. Co., Bridgeport, Conn.

Pipe, Sewer.

Addyston Pipe & Steel Co., Cincinnati, Ohio.

Pipe, Wrought Iron, Line and Drive.

Crane Company, Chicago, Ill.

Planing Mill Machinery.

J. A. Fay & Egan Co., Cincinnati, Ohio.
C. B. Rogers & Co., Norwich, Conn.

Plating Materials.

Eddy Electric Manufacturing Co., Windsor, Conn.

Portable Railways.

O. W. Hunt Co., 45 Broadway, N. Y.

Portland Cement.

Atlas Cement Co., 143 Liberty St., New York.

Power Hammers.

Beaudry & Co., Boston, Mass.
Stiles & Fladd Press Co., Watertown, N. Y.

Power Punches and Shears.

Beaudry & Co., Boston, Mass.

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Long & Allstatter Co., Hamilton, Ohio.
Stiles & Fladd Press Co., Watertown, N. Y.

Power Transmission Machinery.

Filer & Stowell Co., Milwaukee, Wis.

Preservation of Lumber.

Otis Allen & Son, Lowell, Mass.

Presses, Hydraulic, Etc.

Maryland Steel Co., Sparrows Point, Md.
Niles Tool Works, Hamilton, Ohio.
Stiles & Fladd Press Co., Watertown, N. Y.
Watson & Stillman Co., 210 E. 43d St., New York.

Prospecting Drills.

American Well Works, Aurora, Ill.
M. C. Bullock Mfg. Co., Chicago, Ill.
Sullivan Machinery Co., Chicago, Ill.

Pulleys, Shafting and Hangers.

Edw. P. Allis Co., Milwaukee, Wis.
Fishkill Landing Machine Co., Fishkill, N. Y.
Gates Iron Works, Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.
Robert Poole & Son Co., Baltimore, Md.
Wm. Sellers & Co., Philadelphia, Pa.
Robt. Wetherill & Co., Chester, Penn.

Pulverizers.

Bradley Pulverizer Co., Boston, Mass.
Colorado Iron Works, Denver, Colo.

Pumps and Pumping Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
American Well Works, Aurora, Ill.
A. S. Cameron Steam Pump Works, E. 23d St., N. Y
Colorado Iron Works, Denver, Colo.
Connersville Blower Co., Connersville, Ind.
Cook Well Co., St. Louis, Mo.
Filer & Stowell Co., Milwaukee, Wis.
Laidlaw-Dunn-Gordon Co., Cincinnati, Ohio.
Deane Steam Pump Co., Holyoke, Mass.
Gates Iron Works, Chicago, Ill.
Guild & Garrison, Brooklyn, N. Y.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Jeanesville Iron Works, Jeanesville, Pa.
John H. McGowan Co., Cincinnati, Ohio.
New York Air Brake Co., 66 Broadway, N. Y.
Pulsometer Steam Pump Co., 120 Liberty St., N. Y.
Wm. E. Quimby, 59 Liberty St., New York.
Southwark Foundry & Machine Co., Phila., Pa.
Stillwell-Bierce & Smith-Valle Co., Dayton, Ohio.
Webster, Camp & Lane Machine Co., Akron, Ohio.
R. D. Wood & Co., Philadelphia, Pa.

Quarrying Machinery.

M. C. Bullock Mfg. Co., Chicago, Ill.
John F. Byers Machine Co., Ravenna, Ohio.
A. S. Cameron Steam Pump Works, E. 23d St., N. Y.
Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
J. S. Mundy, Newark, N. J.
Rand Drill Co., 100 Broadway, N. Y.
Sullivan Machinery Co., Chicago, Ill.
Trenton Iron Co., Trenton, N. J.

Radiator Screens.

Harrington & King Perforating Co., Chicago, Ill.

Radiators.

Crane Company, Chicago, Ill.
H. B. Smith Co., 137 Center St., N. Y.

Railroad Ditchers.

Jeffrey Mfg. Co., Cleveland, O.
Marion Steam Shovel Co., Marion, Ohio.
Maryland Steel Co., Sparrows Point, Md.
Vulcan Iron Works, Toledo, Ohio.

Railway Car Brakes.

Westinghouse Air Brake Co., Pittsburg, Pa.
New York Air Brake Co., 66 Broadway, N. Y.

Railway Feed Wires.

The Okonite Co., Limited, 13 Park Row, N. Y.

Railway Shop Machinery.

Armstrong Mfg. Co., Bridgeport, Conn.
W. F. & John Barnes Co., Rockford, Ill.
Beaudry & Co., Boston, Mass.
Bradford Mill Co., Cincinnati, Ohio.
Brown & Sharpe Mfg. Co., Providence, R. I.
J. A. Fay & Egan Co., Cincinnati, Ohio.
Ingersoll Milling Machine Co., Rockford, Ill.
Davis & Egan Machine Tool Co., Cincinnati, Ohio.
Lodge & Shipley Machine Tool Co., Cincinnati, O.
Long & Allstatter Co., Cincinnati, Ohio.
Manning, Maxwell & Moore, 111 Liberty St., N. Y.
Niles Tool Works, Hamilton, Ohio.
Q. & C. Co., Chicago, Ill.
C. B. Rogers & Co., Norwich, Conn.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
Stow Manufacturing Co., Binghamton, N. Y.
Watson & Stillman Co., 210 E. 43d St., New York.
The Wright Co., Lowell, Mass.

Railway Specialties.

Harrington & King Perforating Co., Chicago, Ill.
New York Air Brake Co., 66 Broadway, N. Y.
H. K. Porter & Co., Pittsburg, Pa.
Westinghouse Air Brake Co., Pittsburg, Pa.

Railways, Portable.

C. W. Hunt Co., 45 Broadway, N. Y.

Rawhide Pinions.

New Process Rawhide Co., Syracuse, N. Y

Reducing Valves.

Ross Valve Co., Troy, N. Y.
Van Auken Steam Specialty Co., Chicago, Ill.

Refrigerating Machinery.

Frick Company, Waynesboro, Pa.

Road-Making Machinery.

Addyston Pipe & Steel Co., Cincinnati, Ohio.
Marion Steam Shovel Co., Marion, Ohio.
Vulcan Iron Works, Toledo, Ohio.

Road Rollers.

Addyston Pipe & Steel Co., Cincinnati Ohio.

Rock Breakers.

Edw. P. Allis Co., Milwaukee, Wis.
Bradley Pulverizer Co., Boston, Mass.
Colorado Iron Works, Denver, Colo.
Gates Iron Works, Chicago, Ill.

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Rock Drills.

M. C. Bullock Mfg. Co., Chicago, Ill.
Clayton Air Compressor Works, 26 Cortlandt St., N. Y.
General Electric Co., 44 Broad St., New York.
Ingersoll-Sergeant Drill Co., 26 Cortlandt St., N. Y.
Rand Drill Co., 100 Broadway, N. Y.
Sullivan Machinery Co., Chicago, Ill.

Rolling Mill Machinery.

Long & Allstatter Co., Hamilton, Ohio.
Maryland Steel Co., Sparrows Point, Md.
Robert Poole & Son Co., Baltimore, Md.

Roofing.

Berlin Iron Bridge Co., East Berlin, Conn.
Cincinnati Corrugating Co., Piqua, Ohio.
Gummey, McFarland & Co., Philadelphia, Pa.
N. & G. Taylor Co., Philadelphia, Pa.
Passaic Rolling Mill Co., Paterson, N. J.
Riter & Conley, Pittsburg, Pa.
Standard Paint Co., 2 Liberty St., N. Y.
Translucent Fabric Co., Boston, Mass.
Wheeling Corrugating Co., Wheeling, W. Va.

Roofs, Iron, Truss.

Continental Iron Works, Brooklyn, N. Y.
Berlin Iron Bridge Co., East Berlin, Conn.
Maryland Steel Co., Sparrows Point, Md.
Passaic Rolling Mill Co., Paterson, N. J.
Riter & Conley, Pittsburg, Pa.
Wrought Iron Bridge Co., Canton, Ohio.

Rope Transmission.

H. Channon Company, Chicago, Ill.
C. W. Hunt Co., 45 Broadway, N. Y.
Jeffrey Mfg, Co., Columbus, Ohio.
Link-Belt Engineering Co., Nicetown, Phila Pa.,

Rosendale Cement.

New York & Rosendale Cement Co., 280 Broadway, N. Y.

Rubber Goods.

Boston Belting Co., Boston, Mass.
N. J. Car Spring & Rubber Co., Jersey City, N. J.
Jenkins Brothers, 71 John St., N. Y.
New York Belting & Packing Co., Ltd., New York.

Rust Preventive.

Otto Goetze, 114 Broad St., New York.

Saw Mill Machinery.

Edw. P. Allis Co., Milwaukee, Wis.
Filer & Stowell Co., Milwaukee, Wis.

Schools.

Bliss School of Electricity, Washington, D. C.
International Correspondence Schools, Scranton, Pa.

Screens, Mining.

Gates Iron Works, Chicago, Ill.
Harrington & King Perforating Co., Chicago, Ill.
Jeffrey Mfg. Co., Columbus, Ohio.

Screen Plates, Punched.

Harrington & King Perforating Co., Chicago, Ill.

Screw Machines.

Jones & Lamson Mch. Co., Springfield, Vt.
Davis & Egan Machine Tool Co., Cincinnati, Ohio.
Niles Tool Works, Hamilton, Ohio.

Sectional Coverings.

New York Fireproof Covering Co., 42 Cortlandt St., N. Y.

Separators, Coal and Ore.

F. D. Cummer & Son Co., Cleveland, Ohio.

Separators, Steam.

Goubert Mfg. Co., 14 Church St., N. Y.

Shafting.

SEE PULLEYS, ETC.

Sheet Metal Tools.

Stiles & Fladd Press Co., Watertown, N. Y.

Shoes and Dies.

Chrome Steel Works, Brooklyn, N. Y.
Gates Iron Works, Chicago, Ill.

Skylights

Translucent Fabric Co., Boston, Mass.

Smokestacks.

Clonbrock Steam Boiler Co., Brooklyn, N. Y.
Maryland Steel Co., Sparrows Point, Md.
New York Central Iron Works Co., Geneva, N. Y.
Riter & Conley, Pittsburg, Pa.

Spark Guards, Perforated.

Harrington & King Perforating Co., Chicago,

Standpipes.

Maryland Steel Co., Sparrows Point, Md.
Riter & Conley, Pittsburg, Pa.

Steam and Gas Fitters Tools.

Crane Company, Chicago, Ill.

Steam Regulating Appliances.

Penberthy Injector Co., Detroit, Mich.
Jenkins Brothers, 71 John St., N. Y.
Lunkenheimer Co., Cincinnati, Ohio.
Reliance Gauge Co., Cleveland, Ohio.
Ross Valve Co., Troy, N. Y.

Steamships and Tow Boats.

Atlantic Works, East Boston, Mass.

Steam Shovels.

Thomas Carlin's Sons, Allegheny, Pa.
Marion Steam Shovel Co., Marion, Ohio.
Vulcan Iron Works, Toledo, Ohio.

Steam Traps.

Buffalo Forge Co., Buffalo, N. Y.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Van Auken Steam Specialty Co., Chicago, Ill.

Steel Importers.

Wm. Jessop & Sons, Ltd., 91 John St., N. Y.

Steel Manufacturers.

Chrome Steel Works, Brooklyn, N. Y.
Wm. Jessop & Sons, Ltd., 91 John St., N. Y.
Passaic Rolling Mill Co., Paterson, N. J.

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Structural Iron Work.

Continental Iron Works, Brooklyn, N. Y.
Berlin Iron Bridge Co., East Berlin, Conn.
Maryland Steel Co., Sparrows Point, Md.
Passaic Rolling Mill Co., Paterson, N. J.
Riter & Conley, Platsburg, Pa.
Wrought Iron Bridge Co., Canton, Ohio.

Surveying Instruments.

Theo. Alteneder & Sons, Philadelphia, Pa.
Brandis Sons Co., Brooklyn, N. Y.
Keuffel & Esser Co., 127 Fulton St., New York.
Queen & Co., Inc , Philadelphia, Pa.

Tanks, Iron.

Clonbrock Steam Boiler Co., Brooklyn, N. Y.
Continental Iron Works, Brooklyn, N. Y.
Maryland Steel Co., Sparrows Point, Md.
New York Central Iron Works Co., Geneva, N. Y.
Pittsburg Locomotive Works, Pittsburg, Pa.
Riter & Conley, Pittsburg, Pa.

Tanks, Wood.

Williams Mfg. Co., Kalamazoo, Mich.

Telegraph Wires and Cables.

Eastern Electric Cable Co., Boston, Mass.
John A. Roebling's Sons Co., Trenton, N. J.
The Okonite Co., Ltd., 13 Park Row, N. Y.

Testing Machinery.

Wm. Sellers & Co., Philadelphia, Pa

Thermometers.

Bristol Co., Waterbury, Conn.
Queen & Co., Inc., Philadelphia, Pa.

Tin.

Gummey, McFarland & Co., Philadelphia, Pa.
N. & G. Taylor Co., Philadelphia, Pa.
Wheeling Corrugating Co., Wheeling, W. Va.

Tin Plate Rolling Machinery.

Robert Poole & Son Co., Baltimore, Md.

Tramways.

C. W. Hunt Co., 45 Broadway, N. Y.

Tramways, Wire Rope.

Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
Trenton Iron Co., Trenton, N. J.
C. W. Hunt Co., 45 Broadway N. Y.

Transmission Machinery.

Jeffrey Mfg. Co., Columbus, Ohio.
Robt. Wetherill Co., Chester, Pa.
C. W. Hunt Co., 45 Broadway, N. Y.

Turbines.

James Leffel & Co., Springfield, Ohio.
Robert Poole & Son Co., Baltimore, Md.
S. Morgan Smith, York, Pa.
R. D. Wood, & Co., Philadelphia, Pa.

Turn Tables.

Wm. Sellers & Co., Philadelphia, Pa.

Twist Drills.

Standard Tool Co., Cleveland, Ohio.
Cleveland Twist Drill Co., Cleveland, Ohio.
Morse Twist Drill & Mch. Co., New Bedford, Mass.

Vacuum Pumps.

A. S. Cameron, Steam Pump Works, E. 23d St., N. Y.
Clayton Air Compressor Works, 26 Cortlandt St., N. Y.
Deane Steam Pump Co., Holyoke, Mass.

Valves, Gas, Steam, and Water.

Crane Company, Chicago, Ill.
Jeanesville Iron Works, Jeanesville, Pa.
Jenkins Brothers, 71 John St., N. Y.
Lunkenheimer Co., Cincinnati, Ohio.
Ross Valve Co., Troy, N. Y.

Ventilating Appliances.

American Blower Co., Detroit, Mich.
Buffalo Forge Co., Buffalo, N. Y.
M. C. Bullock Mfg. Co , Chicago, Ill.
Connersville Blower Co., Connersville, Ind.
B. F. Sturtevant Co., Boston, Mass.

Voltmeters.

Fort Wayne Electric Corporation, Fort Wayne, Ind.
Weston Electrical Ins. Co., Newark, N. J.

Water Works Supplies.

American Well Works, Aurora, Ill.
Cook Well Co., St. Louis, Mo.
McNeal Pipe and Foundry Co., Burlington, N. J.

Water Wheels.

James Leffel & Co., Springfield, Ohio.
Robert Poole & Son Co., Baltimore, Md.
S. Morgan Smith, York, Pa.
R. D. Wood & Co., Philadelphia, Pa.

Well Sinking Machinery.

American Well Works, Aurora, Ill.
Cook Well Co., St. Louis, Mo.

Window Guards (Jail Work).

Harrington & King Perforating Co., Chicago, Ill.

Wire.

Charles H. Besly & Co., Chicago, Ill.
Phosphor-Bronze Smelting Co., Ltd., Phila., Pa.

Wire Cloth.

Phosphor-Bronze Smelting Co., Ltd., Phila., Pa.

Wire Rope.

H. Channon Company, Chicago, Ill.
Cooper, Hewitt & Co., 17 Burling Slip, N. Y.
John A. Roebling's Sons Co., Trenton, N. J.
Phosphor-Bronze Smelting Co., Ltd., Phila., Pa.
Trenton Iron Co., Trenton, N. J.

Wood-Working Machinery.

J. A. Fay & Egan Co., Cincinnati, Ohio.
C. B. Rogers & Co., Norwich, Conn.
Stow Flexible Shaft Co., Ltd., Philadelphia, Pa.
The Wilkinson Co., Chicago, Ill.

Wrecking Cars.

Marion Steam Shovel Co., Marion, Ohio.

Yachts, Steam.

Atlantic Works, East Boston, Mass.
Marine Iron Works, Chicago, Ill.

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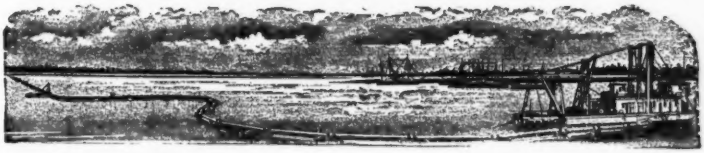
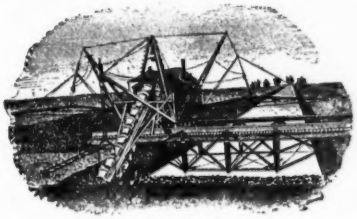
NEW YORK DREDGING CO.,



Hydraulic Dredge discharging through 5,700 Ft. Pipe. Will dig and put ashore any material, Rock excepted.



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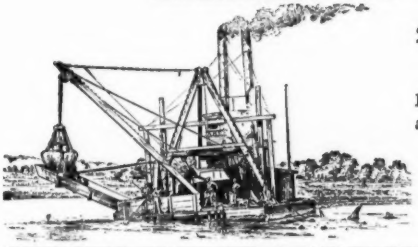
Galveston, Tex. and Oakland, Cal.

BABCOCK-LARY DREDGING CO.,

ENGINEERS AND CONTRACTORS.



29 Broadway, New York.

Dredging and Reclaiming Meadow and Low Lands by our New Vacuum Pump Method a Specialty. Now at work reclaiming 100 Acres of Meadow at Bergen Beach on (Jamaica Bay) Long Island.

Material, Mud and Sand, discharging through 2,000 feet of pipe, 80% solid.

I value the Magazine highly for its usefulness, and look each month to the coming of the next number. It is like an interesting continued story in that respect.

But still the Magazine is so good and useful that I presume that I appreciate it as little as any of your subscribers.

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Seattle, Wn.

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ROSENDALE HYDRAULIC CEMENT
Warranted Superior to any Manufactured.
STRONGEST, DARKEST, UNIFORM, RELIABLE.
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Brooklyn Institute of Arts and Sciences.
New Astor Hotel and Waldorf Hotel Extension.
Telephone Connection.
WM. C. MORTON, Sec'y. . .

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Surveying and Engineering Instruments
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31 See Announcement of The Engineering Index on page 31. This book makes into a useful whole the entire range of engineering literature of the past four years.

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For City, Town and Village Water-Works, Mills, Factories, Hotels, Dwellings, Laundries, Baths, etc., etc.
The CONTINENTAL is the Simplest, Most Efficient and Economical.
Double Filtration—Simplest and Most Efficient Process of Washing Filter Beds.
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The Morison-Jewell Filtration Co. 26 Cortlandt St., N.Y. 26 S. 15th St. Phila.
The Pacific Jewell Filter Co. 222 Sutter St., San Francisco.

TACNA, CHILE, 8th June, 1896.

THE ENGINEERING MAGAZINE,
New York.

GENTLEMEN:

Please send me by registered packet a supply of one hundred (100) coupons. I inclose herewith $12.00 in American bank notes for same.

Yours truly,
CÁRLOS BASADRE Y FORERO, Mining Engineer.

NOTE.—The coupons are for ordering articles from our Index Department. See Review of The Engineering Press.

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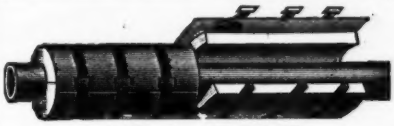

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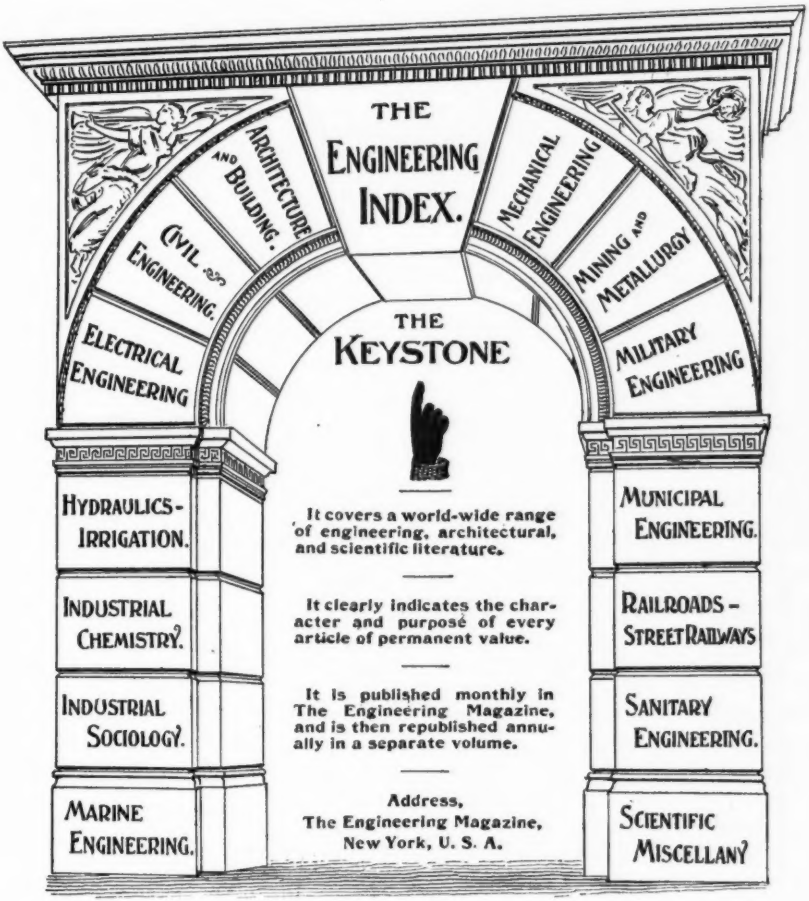
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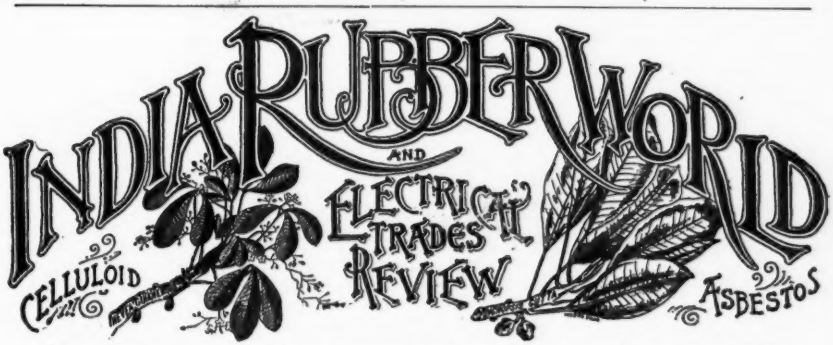

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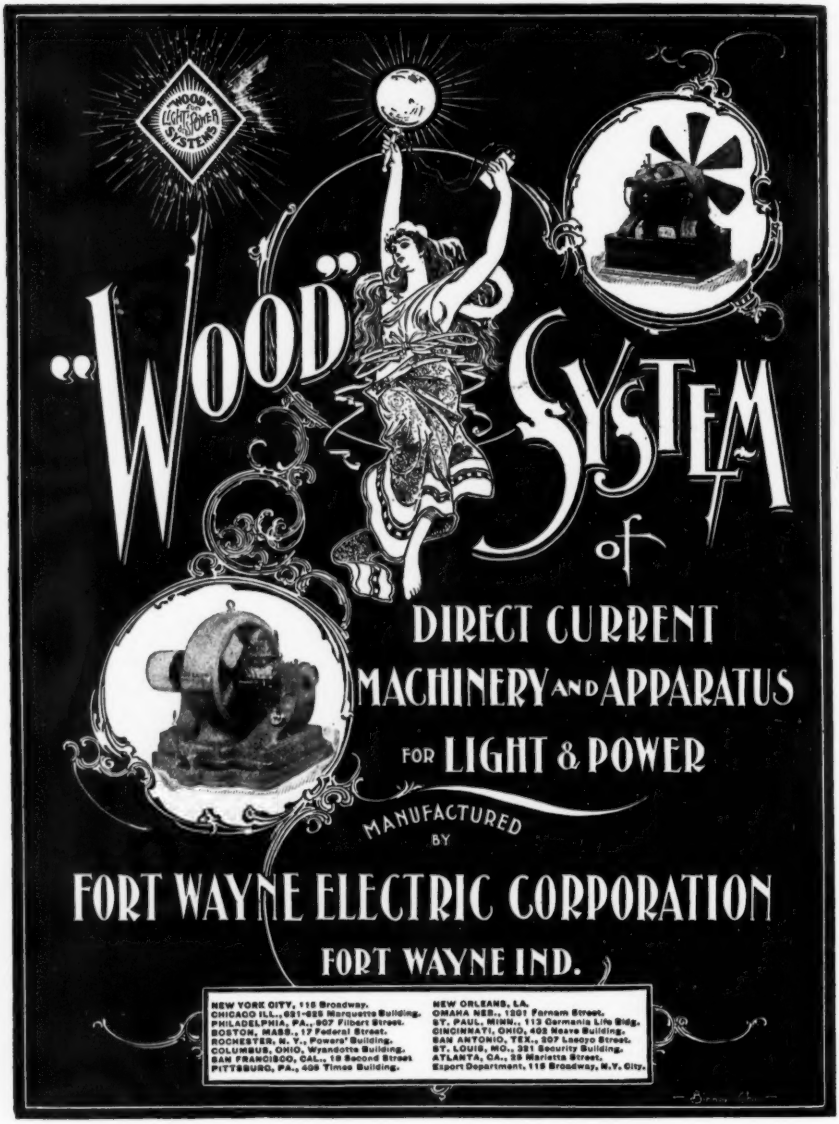
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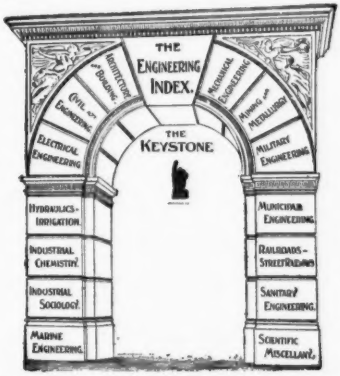

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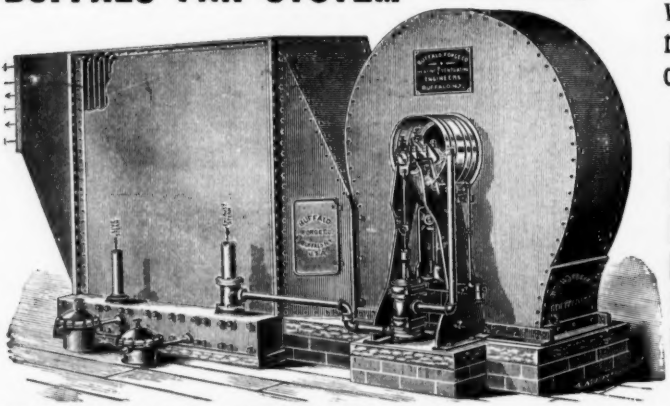

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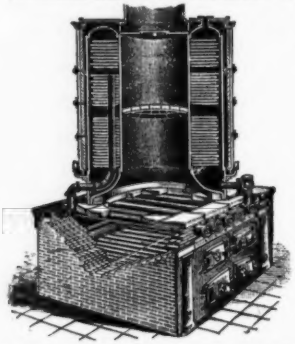

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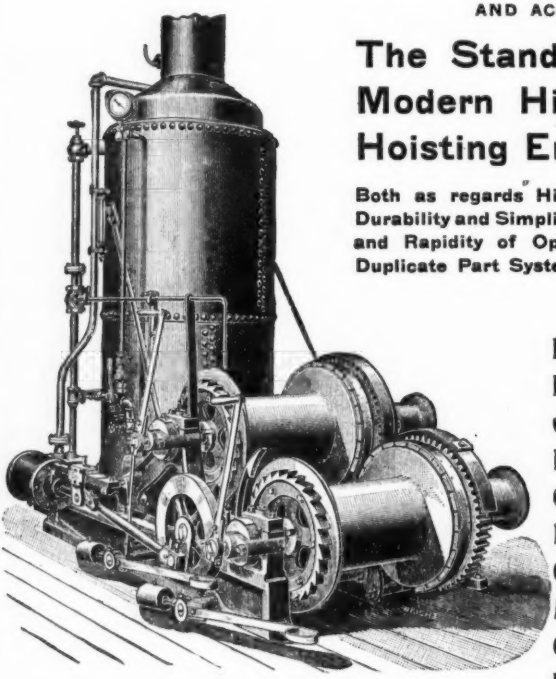

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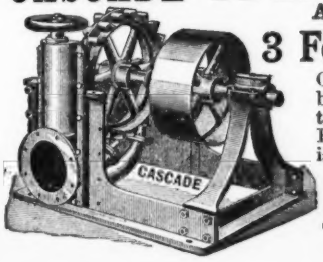

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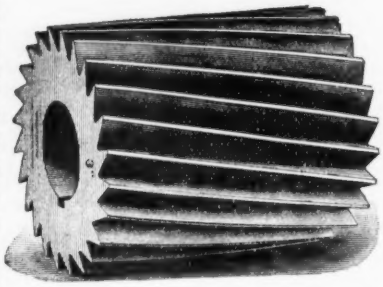

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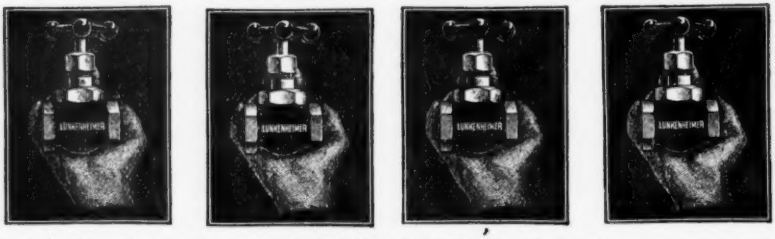

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